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The
HOW
AND
WHY
Wonder Book of

RAILROADS

How and Why Wonder Books

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THE HOW AND WHY WONDER BOOK OF

RAILROADS

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STATE INSTITUTE OF EDUCATION
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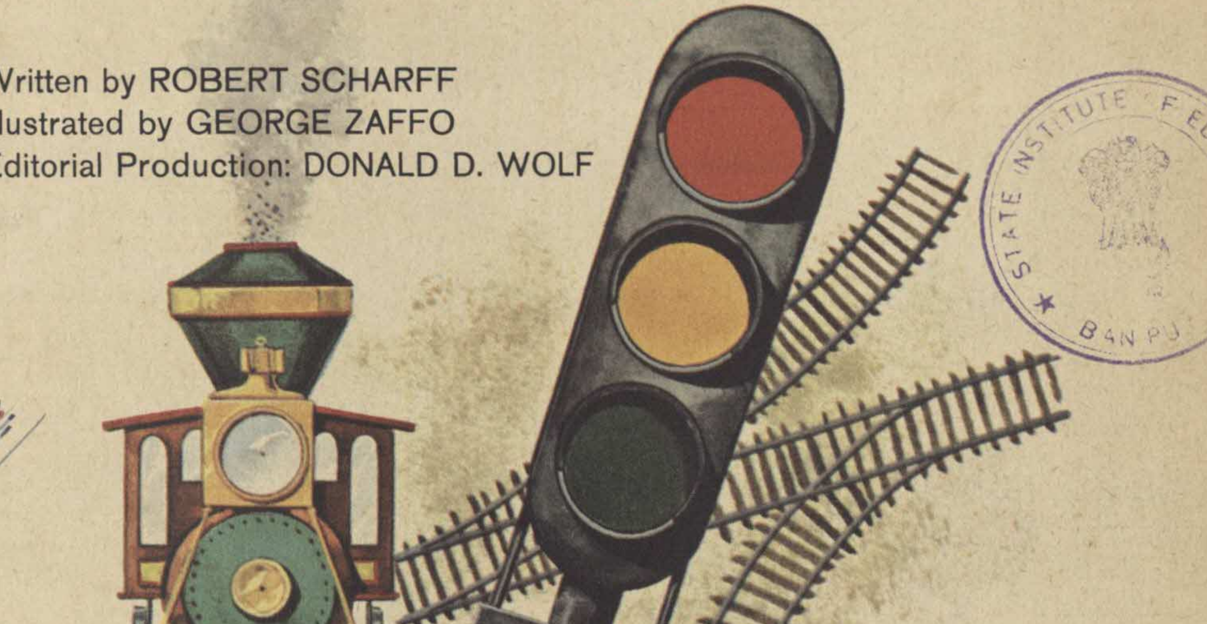

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Oakes A. White, Brooklyn Children's Museum, Brooklyn, New York

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Introduction

Fifty years ago, seeing an airplane was an occasion for much excitement. People ran outdoors to catch a glimpse of a plane passing overhead. Not many years before that, a similar excitement was aroused by the appearance of an automobile. It was a strange and unexpected sight to behold. And fifty years before that, the railroad was an almost unbelievable new mode of transportation. This *How and Why Wonder Book of Railroads* will help you relive those early days as well as learn about recent developments.

From slow beginnings in the early 1800's to phenomenal growth after the 1850's, the railroad played a major part in the economic growth of our nation. For a hundred years or more, it was the most important means of transportation. In recent years, use of the automobile, bus, and airplane has become more popular, and trains are used less for passenger travel. But the great variety of ways the railroads are useful means they will continue to be an important part of our national transportation system for many years to come.

Did you ever ride on a train? Strange as it may seem, many parents and schools make a special occasion of taking children for a train ride to be sure they have the experience. If you are under fifteen, the chances are great that you have not ridden a train. Even so, every educated boy and girl should understand the importance of trains in the history and growth of our country. This *How and Why Wonder Book of Railroads* brings that knowledge to the reader. From the standpoint of history, technology, and engineering, the book is a useful addition to the school and home library.

Paul E. Blackwood

Dr. Blackwood is a professional employee in the U. S. Office of Education. This book was edited by him in his private capacity and no official support or endorsement by the Office of Education is intended or should be inferred.

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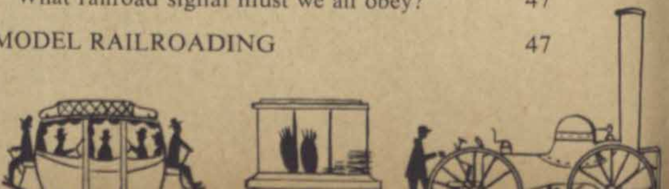


The Beginning of Railroads

Where were the first railroads?

Almost every city or town in the United States is on or near a railroad. In a way, the railroad story is the story of America — its history and its people. It is a story of achievement and progress that produced the greatest transportation system in the world. For the beginning of the story of railroads we must not look in America, but in England.

During the reign of Queen Elizabeth I (1558-1603), short wooden tracks were used in England to connect mines or quarries with nearby streams. Here the coal and stone were transferred to barges. On such tracks, called *tramways,* horses could draw far heavier loads than on ordinary roads.

Later, people began to think the tracks or rails could be used to carry travelers. In those days, the most comfortable way to travel on land was in a stagecoach drawn by horses. But the roads were rough and bumpy all the time. Rails could make travel much smoother and cleaner. The stagecoach was placed on tracks and was pulled by horses. This was the first passenger railroad.

It was not long before iron strips were being placed over the wooden rails. Iron made rails much stronger and they did not wear away so fast. Several carriages could be joined together to make a stagecoach train or wagon. But still, horses could not pull very heavy loads and could not travel very fast.

Many strange ideas were tried out to improve this simple railroad. A horse was placed right in the car, with the passengers, to work a machine called a *treadmill.* The experiments, however, were not successful. Another group of men tried sails on carriages. After all, they thought, sails make ships glide fast and smoothly before the wind. But sails did not work so well on railroad cars. When the wind blew strong enough toward the destination of the carriage, everything was fine. But when the wind changed, the carriage stopped.

Who invented the steam locomotive?

The real development of the car on rails began with the development of the steam engine. The steam locomotive was the invention of no one man. Early models — the *puffing Billy,* the *iron horse,* and the *steam wagon* — were developed from the stationary steam engine invented by an Englishman, Thomas Newcomen, in 1705. Newcomen's model was greatly improved by James Watt sixty-four years later.

The first steam engine to successfully pull loaded cars over a road of rails was built and operated by Richard Trevithick in England in 1804. His engine pulled a short train uphill on a coal mine tramway. It had taken 100 years to develop a railroad locomotive from Newcomen's simple steam engine. During the next twenty years there were several experimental locomotives. The world's first common carrier railroad

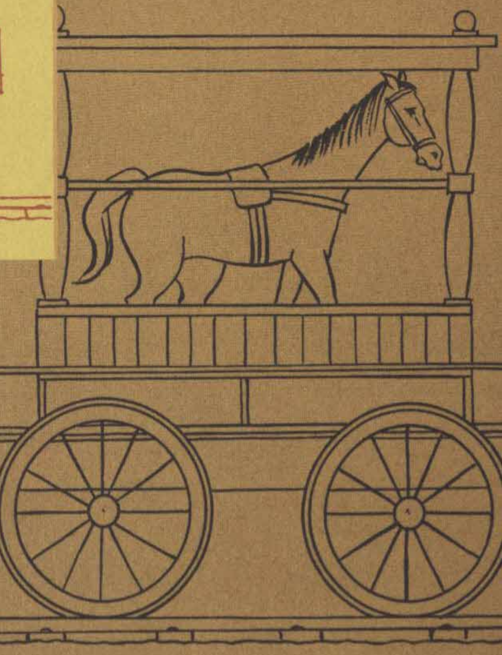
After the coal cars had been a success, people thought of putting a stagecoach on rails to make the ride smoother.

Tramways, short wooden tracks that carried carts drawn by horses, were first used in England to haul coal or stones from mines and quarries.

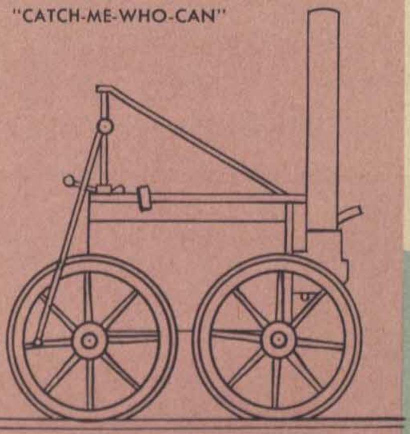
(a railroad for public use) to employ steam power was started in England in 1825. The train was powered by George Stephenson's famous *Locomotion No. 1*. In 1829, Stephenson and his brother Robert built a better, faster engine and called it the *Rocket*. Though the *Rocket* was not the first such locomotive, it is looked upon as the beginning of effective steam power and the beginning of the age of the iron horse.

When the stationary steam engine was "put on wheels" and made to run on rails, it was called a *locomotive en-*

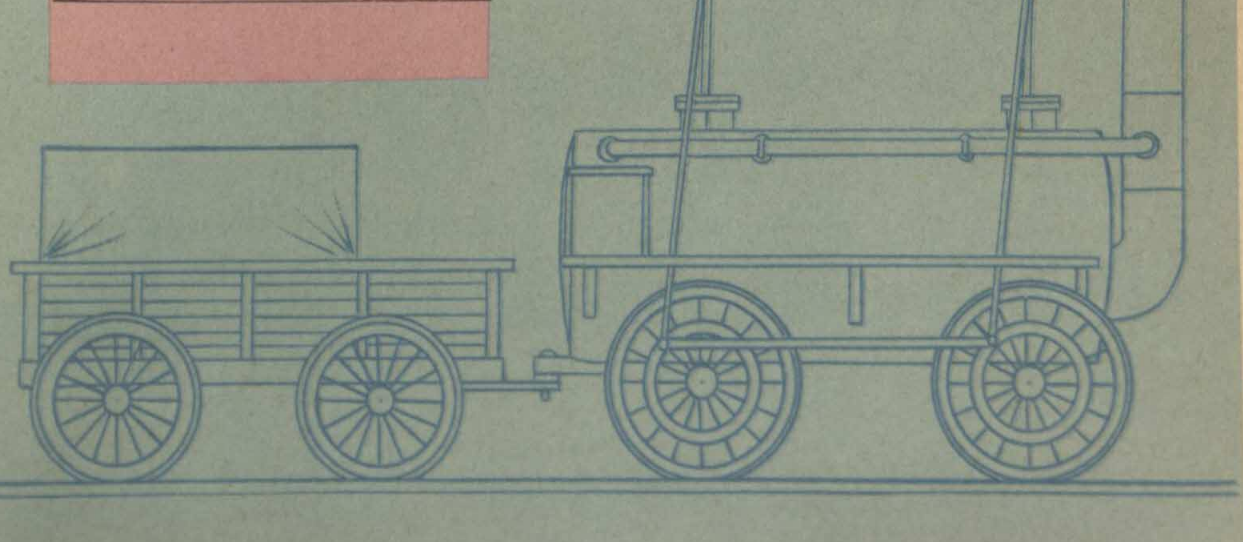
The horse treadmill was soon abandoned as means of passenger transport, just as the sailing car was abandoned.

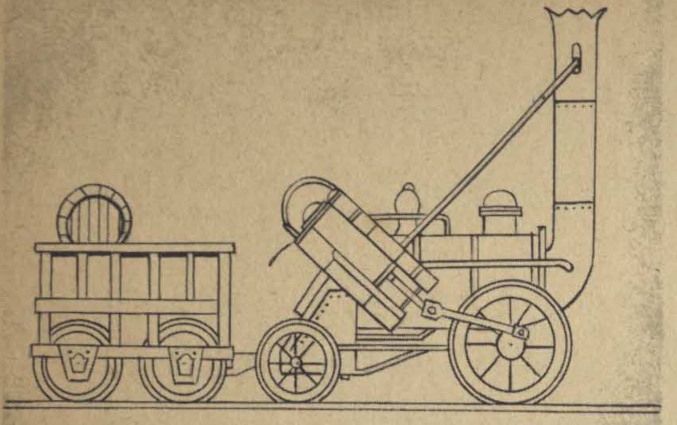


TREVITHICK'S ENGINE, THE "CATCH-ME-WHO-CAN"



STEPHENSON'S "LOCOMOTION NO. 1" ON ITS FIRST PASSENGER RUN.





The Rocket, built by George Stephenson and his brother Robert in 1829 as an improvement over the "Locomotion No. 1," was the first practical locomotive. It opened the railroad era.

gine, because it could move from place to place under its own power (locomotion). Later, it became simply a *locomotive* or an *engine,* and both terms have been in common use for many years.

What was the first railroad in the United States?

The first road of rails in the United States was probably a short inclined track used in Boston as early as 1795. The first railway company to build and operate a railroad in this country was Granite Railway Company, incorporated in Massachusetts in 1826. The cars were drawn by horses. The first railroad for passengers and freight was the Baltimore & Ohio which was opened for horse-drawn traffic in 1830.

An English-built locomotive, the *Stourbridge Lion,* was brought to America in 1829 by Horatio Allen, a young civil engineer, aboard a sailing vessel. It made a two-mile trial run on a coal track in Pennsylvania — the first steam engine to move on a regular railroad in this country. But the six-ton *Lion* proved too heavy for the rails and too stiff for the curves, and was honorably retired to serve as a stationary steam engine after its first run.

In America, too, people were beginning to build locomotives. In 1825, the first steam engine in the United States was built by Colonel John Stevens of New Jersey. This locomotive was operated on a circular track on his estate, but it was never used for commercial purposes.

The first really successful locomotive was the *Tom Thumb,* built by Peter Cooper, another young civil engineer, in 1830. People lined the tracks in Baltimore to see the wonderful sight of an iron horse going at the unheard of speed of 18 miles an hour. This pint-sized engine, weighing only about one ton, once ran a race with a fast stagecoach horse. It was an exciting event; the puff-

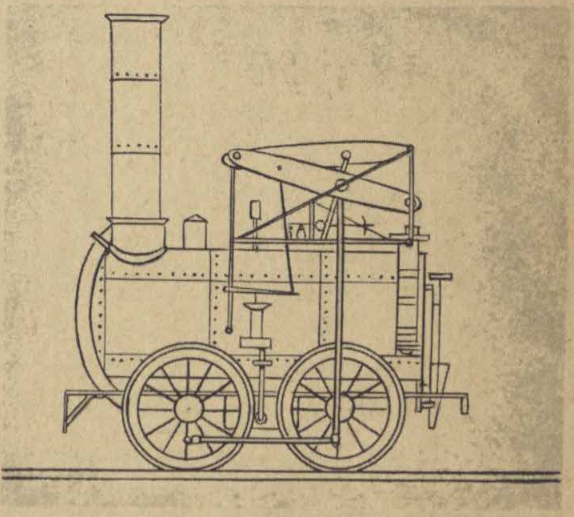
ing of the horse matched the puffing of the *Tom Thumb*. At first the locomotive drew ahead. Then, just at the worst possible moment, the *Tom Thumb* had a mechanical breakdown and the horse won the race. Before many years had passed, however, other iron horses were winning victories over stagecoaches.

What was the first locomotive placed in regular service in America?

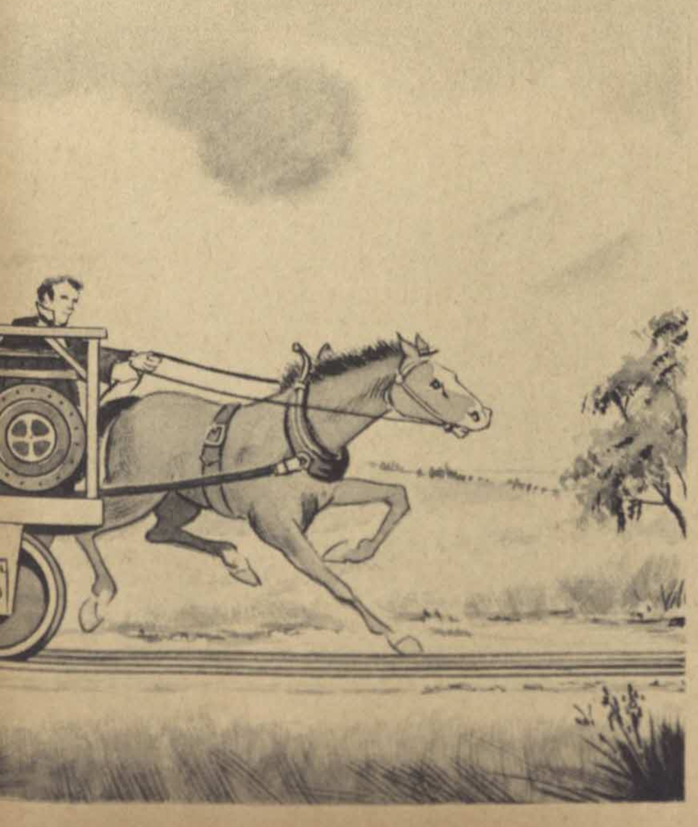
While Peter Cooper was trying to "sell" his *Tom Thumb* to officials of the Baltimore & Ohio Railroad, Horatio Allen was helping to start a railroad in South Carolina. On December 25, 1830, the South Carolina Railroad (now the Southern Railway System) became the first railroad company or *line* to use steam power in regular service. The locomotive, *Best Friend of Charleston,* pulled the first train of cars over their rails. A year later, this railroad began carrying the United States mail. In 1833, the Southern line was extended to 136 miles, making it the longest railroad in the world at that time.

What was traveling like on early trains?

Let us take an imaginary trip behind the famous *De Witt Clinton.* This was the third locomotive built in America and it was put into service between Albany and Schenectady in New York State on August 9th, 1831. The entire train consisted of a four-wheeled engine, a tender containing water and firewood, two passenger cars made from bodies of stagecoaches and fastened on the rails. The cars were connected with a three-link chain about a yard in length. The engine was 11½



The English-built "Stourbridge Lion" was brought to the United States in 1829.



The famous race between Peter Cooper's "iron horse" and a horse from its challenger's stagecoach line on August 25, 1830, was won by the horse. The "Tom Thumb" developed engine trouble and came to a dead stop.

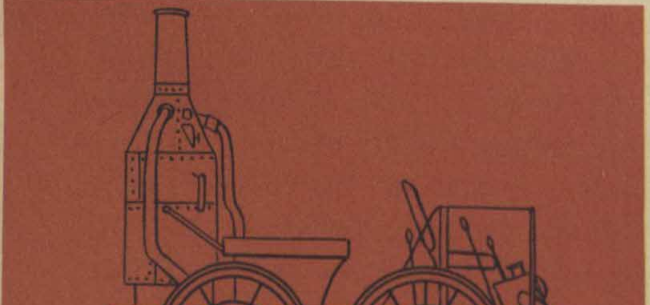
feet long and had a towering smokestack. One man operated the engine.

Tickets for the trip were sold at hotels and other public places. Passengers climbed into the carriages and took their seats. Then the conductor, standing on the platform outside each coach, collected the tickets, mounted to a little seat on the tender and blew a horn as a signal for the engineer to start the train. As the train started to move, there was usually a terrific jerk that sent the passengers in the coaches sprawling across each other. But once the passengers got back to their seats, the engine moved along smoothly. Then, as the fire in the boiler got hot, sparks, cinders and smoke showered the passengers. They had to beat the flames from their burning clothes, and put up umbrellas. When the train had to stop, the engineer pushed a lever that was designed to apply brakes to the wheels and slow the train. The device worked well; the engine generally was abruptly checked, the tender bumped into the locomotive, the first passenger car crashed against the tender, and the second coach rammed the first. The passengers, usually still fighting the sparks, were again sent sprawling, now forward from their seats instead of backward as they had been when the train started.

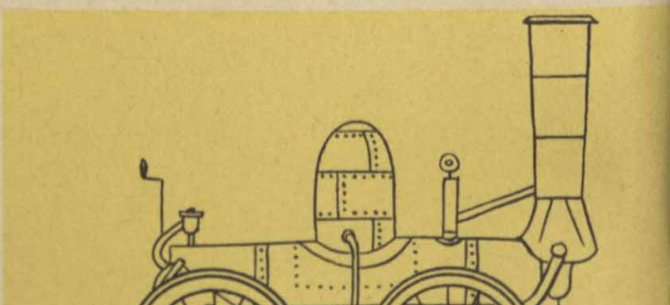
Train schedules were somewhat irregular in those days. When it rained, trains could not run because they had no way to keep from slipping on the wet tracks. They could not run at night because there were no lights on the trains. There were many delays in the service, too. Often the train ran out of firewood, and the passengers had to help gather more wood so that the journey of the iron horse could continue.

What problems faced the early railroads?

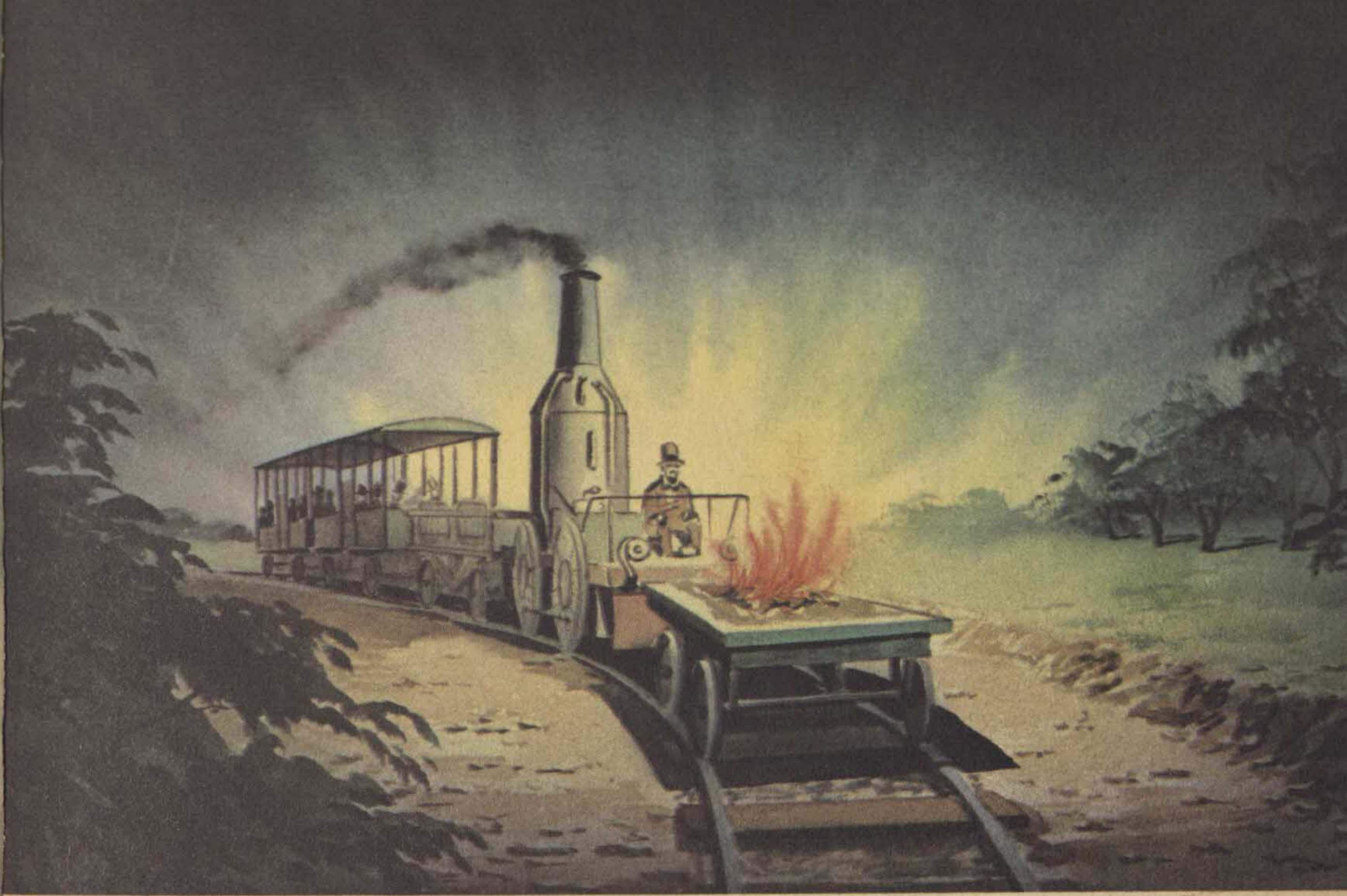
The railroads had many problems in the early days. Some people were strongly opposed to all railroads and held mass meetings against them. Other people claimed that the cattle would be injured and that is was not healthful to travel at the dangerous speed of 15 miles an hour; also you might be blown up! Unfortu-



"Best Friend" pulled the first train in regular service in America over South Carolina Railroad tracks.



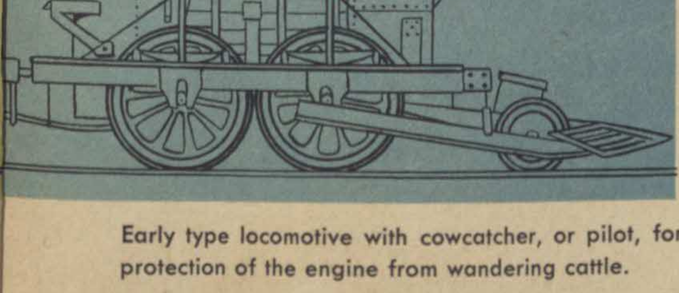
The "De Witt Clinton," built in 1831, was the third locomotive engine built in the United States.



A flatcar with a bonfire in front of the locomotive took care of the illumination of early railroads on night rides.

nately there was some evidence to support these claims, but the railroaders did what they could to make travel safe.

To protect the engine from wandering cattle, a small truck (a set of wheels) was put ahead of it. One type truck model had two iron spears attached. Later a crossbar was substituted, and this in time became the V-shaped *cowcatcher* or pilot.



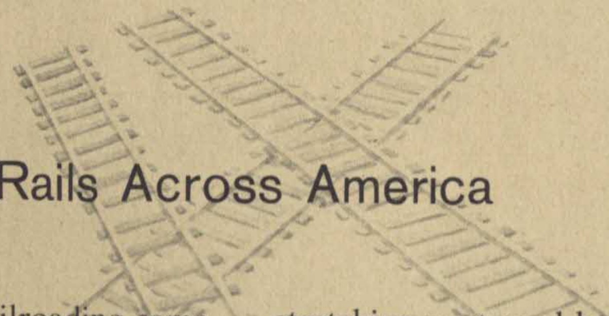
Early type locomotive with cowcatcher, or pilot, for protection of the engine from wandering cattle.

Most of the early locomotives had simple brakes or no brakes at all. When a train puffed into its destination, a group of citizens ran out, grabbed the train wherever it was handy, and pulled it to a stop. After these pioneer trains had been operated for a while using the trial and error method, the brakes were improved until the present air brakes came into use. These automatic brakes, worked by compressed air and controlled from the locomotive, can be applied throughout a long train in a few seconds.

The first trains ran only in daylight hours, and headlights were unknown.

As time went on, however, night operations became increasingly necessary, and inventive minds went to work to devise ways of illuminating the track ahead of the train. The first step was taken by Horatio Allen when he attached a small flatcar to the front of the locomotive and covered the floor of the car with a heavy layer of sand on which he kept a bonfire of pine knots. Soon, though, reflectors and oil lamps came into use. Today, our locomotives are equipped with electric headlights.

Out of such problems and necessities came inventions. As the railroads grew, they created new problems. Ingenious men concentrated on them and many problems were solved by several men working independently. Eventually all the problems were solved.



Rails Across America

What was the period of expansion?

New developments in railroading came swiftly in the first thirty years (1830 to 1860). Cars and track were improved. Oil lamps were used to permit trains to travel at night. In 1851, railroads put the telegraph to work to speed up their services. People flocked to ride the "steam cars" and excursion trains were popular.

The first American railroads started from the east coast ports of Boston, New York City, Philadelphia, Wilmington, Charleston, and Savannah. Within 20 years, four rail lines had crossed the Allegheny Mountains to reach their goal on the "Western Waters" of the Great Lakes or on the tributaries of the Mississippi River. Meanwhile, other lines had started west of the mountains, and by the mid-1850's, Chicago, St. Louis, and Memphis were connected with the East. Still other lines were stretching westward beyond the Mississippi River, and by 1860 the "Iron Horse" was operating in Missouri. Before Abraham Lincoln had been inaugurated and Fort Sumter had been fired upon in the spring of 1861 to start the Civil War, railroads had appeared in Arkansas and Kansas. With eleven operating lines, Chicago had become the leading railroad center of the nation, a position it has never since relinquished.

What part did railroads play in the Civil War?

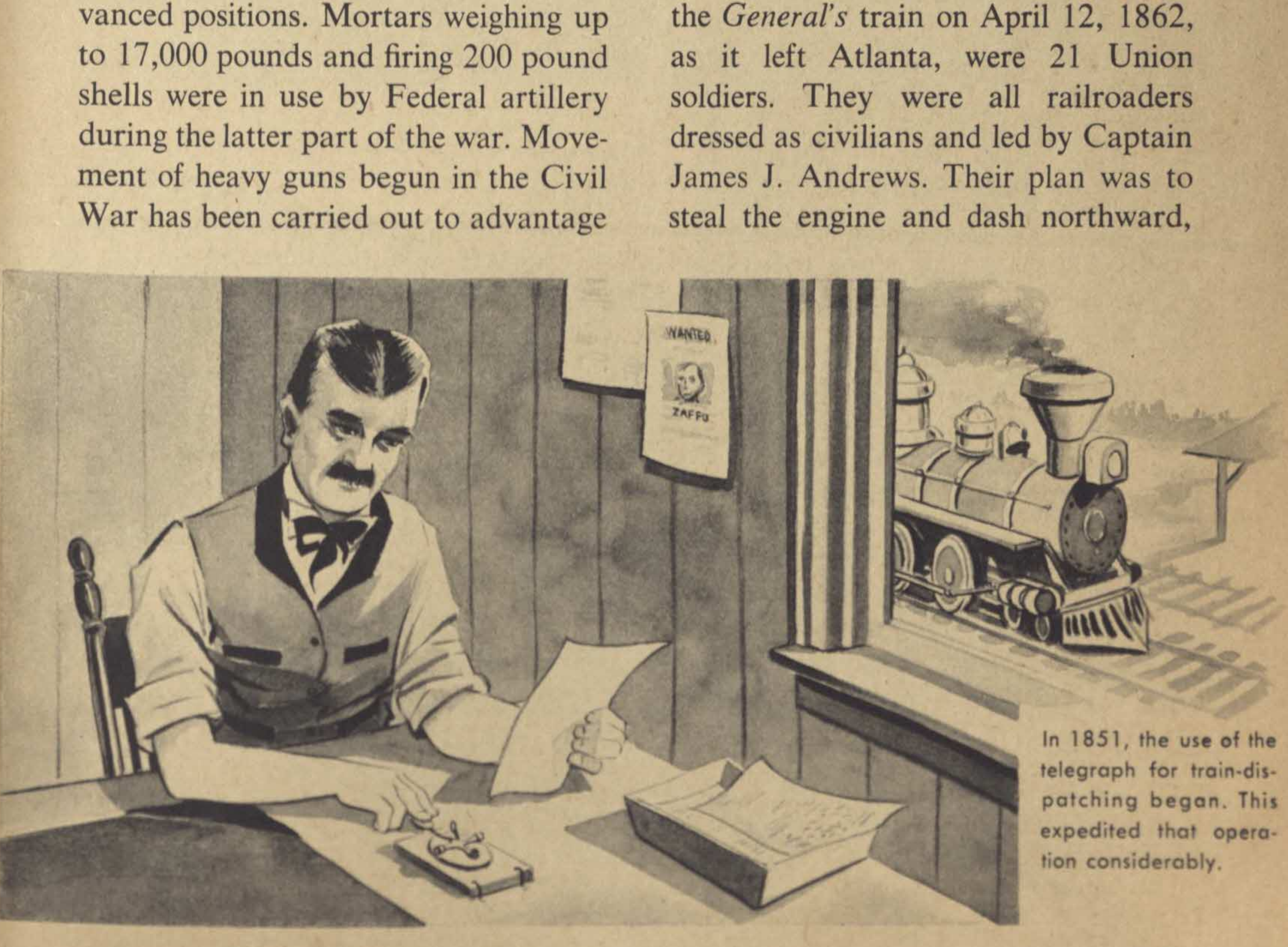
When the Civil War broke out in 1861, railroads of both the North and the South went into action at once. Railroad trains transported troops to training centers and to the fighting fronts. Quite frequently, the winning or losing of an important battle was dependent on how well-organized the railroad operation plan was. For instance, when the Federal forces began their campaign around Chattanooga, Tennessee, the longest Confederate troop movement took place — the transportation of the First Corps of the Army of Northern Virginia to Chickamauga. Trains pounded over hundreds of miles of track southward from Virginia, through North and South Carolina, and Georgia, and to within a few miles of the fighting front. When the troops detrained, they joined the local defenders in the Battle of Chickamauga in time to win an important victory.

Special military uses of railroads were developed during the war between the states, particularly by the northern armies. Guns were mounted on specially-built cars and moved up to advanced positions. Mortars weighing up to 17,000 pounds and firing 200 pound shells were in use by Federal artillery during the latter part of the war. Movement of heavy guns begun in the Civil War has been carried out to advantage in subsequent wars over tracks built and maintained by the U. S. Military Railway Service.

What was the most exciting train fight in the Civil War?

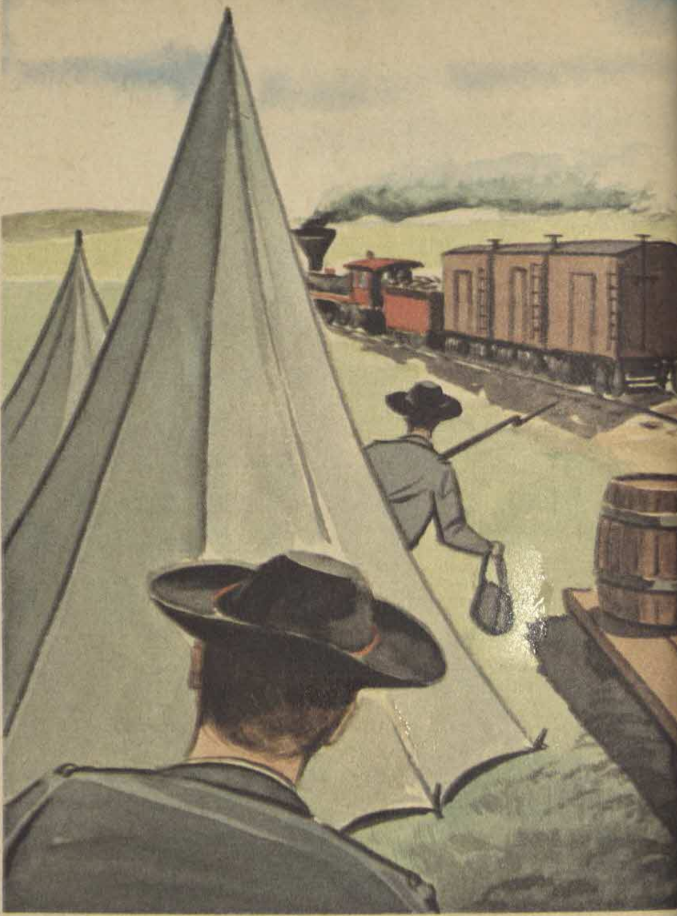
Railroads were so important in their "first war," that both sides worked hard to destroy or capture the railway supply lines of the enemy. One of the most spectacular thrusts was aimed at the railroad connecting Atlanta, Georgia, with Chattanooga, Tennessee. On this line, the famous train fight known as the "Chase of the *General*" took place.

The *General* was a fast-wheeling, wood-burning locomotive used to pull a passenger and mail train. On board the *General's* train on April 12, 1862, as it left Atlanta, were 21 Union soldiers. They were all railroaders dressed as civilians and led by Captain James J. Andrews. Their plan was to steal the engine and dash northward,



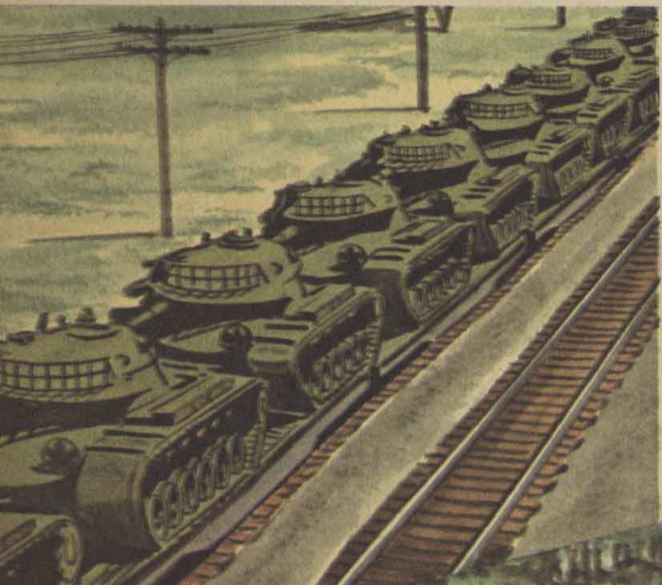
In 1851, the use of the telegraph for train-dispatching began. This expedited that operation considerably.

The "General," seized by Andrews' raiders, throttle wide open, speeds out of Big Shanty station.

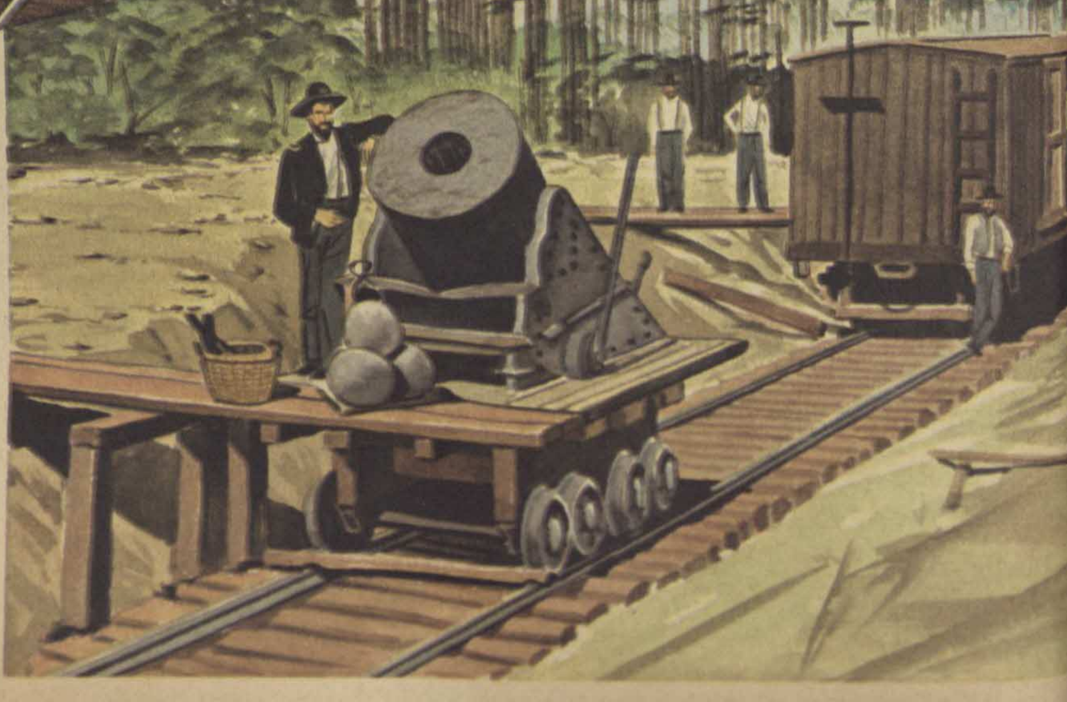


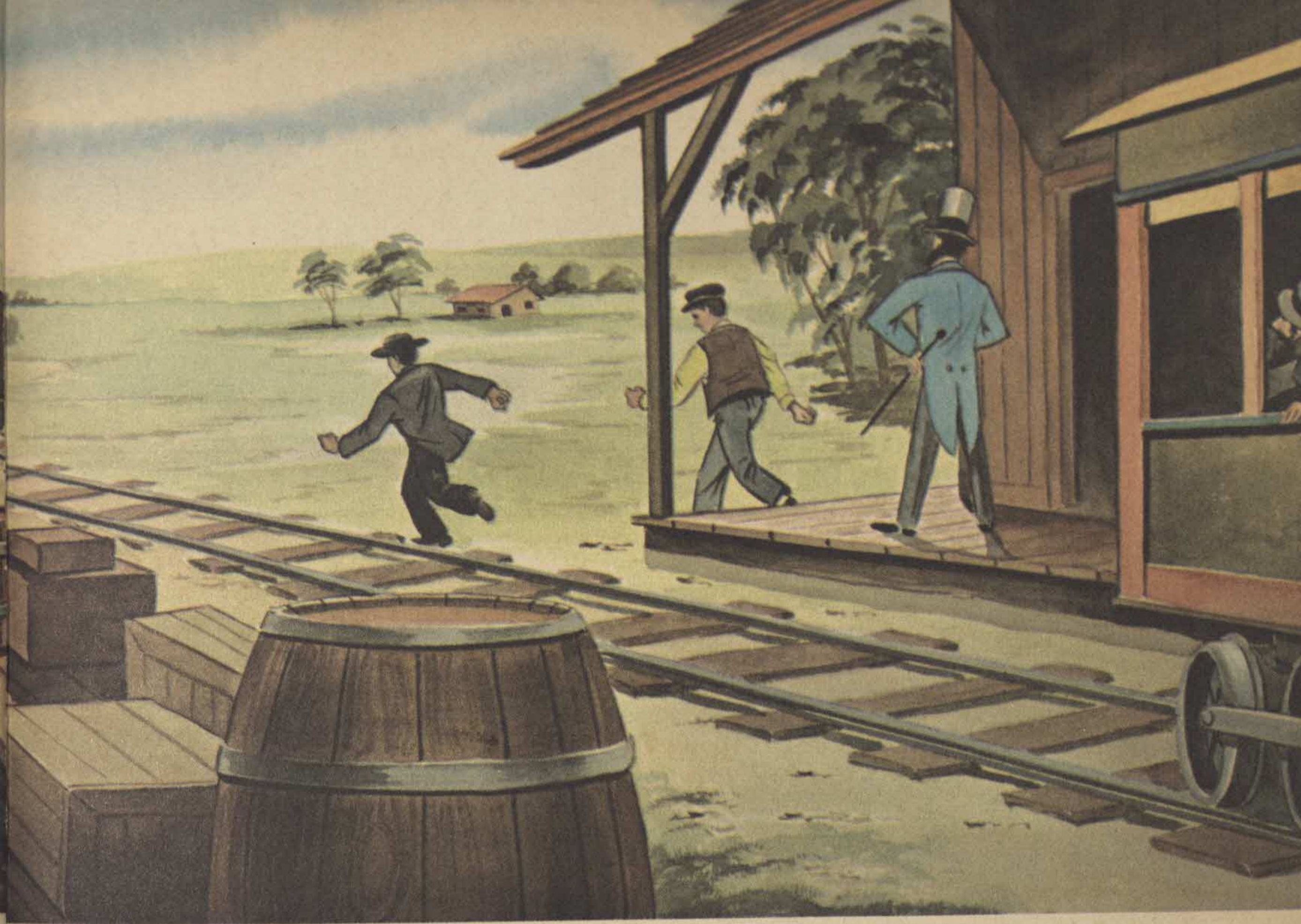
cutting the Confederate line of communication to Chattanooga. As the train neared Big Shanty (now Kennesaw, Georgia) where a Confederate training camp was located, a stop was made for breakfast. (Trains in those days did not have dining cars.) The crew of the train and the passengers

The use of the railroad by the military started during the War Between the States and continues today. Our picture shows modern tanks loaded on flatcars en route from one army camp to another.



The 13-inch mortar shown in the foreground was named the "Dictator." It was mounted on a railroad car used by the Federal Artillery around St. Petersburg, Florida, during the closing months of the War Between the States. It weighed 17,000 pounds and fired a 200-pound shell with 20 pounds of powder.





hurried into the trackside restaurant. Conductor W. A. Fuller and his engineer, Jeff Cain, had taken seats at the table when Fuller, who was facing the window toward the track, saw several men climbing into the locomotive cab. Fuller ran outside, followed by the rest of the train crew, but Andrews' raiders had uncoupled the engine and three head-end boxcars from the coaches and were speeding up the track with the *General's* throttle wide open.

Fuller and his engineer ran after the train for two miles and met a track repair gang who told them that the raiders had taken their tools and cut the telegraph wire. Taking the hand operated car, Fuller kept up the chase, and though derailed once at a place where Andrews' men had loosened a rail, soon reached Etowah Station. There on a side track was the *Yonah,* an old yard engine, and Fuller lost no time getting it out on the main line. Joined by several soldiers, Fuller and the engine crew pursued the raiders.

When Captain Andrews arrived at Kingston, the single track line was blocked waiting for a special southbound train to arrive. After an hour's delay, the track was cleared, and the stolen train was speeding northward again. But conductor Fuller was close behind, having taken another engine and one car from a train at Kingston. Soldiers and railroaders were aboard.

Ahead Andrews' raiders stopped long enough to cut the telegraph wires and to take up some of the rails. Unfortunately, it was raining furiously and they could not take the time necessary to try to burn the wooden bridges they crossed. But they did wreck a section of the track.

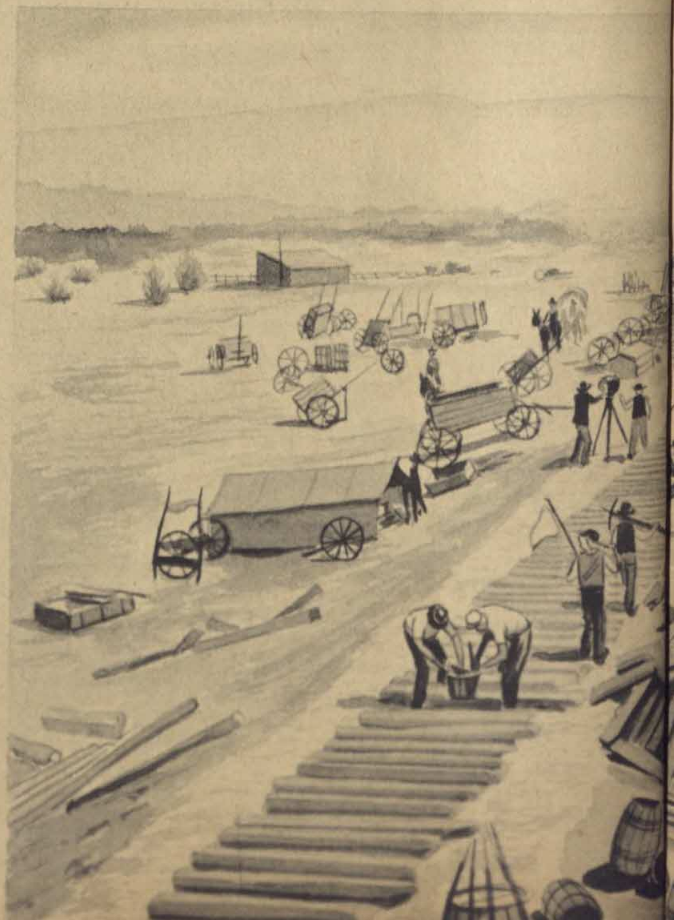
Reaching the break in the track, Fuller ran two miles, stopped a southbound freight train, switched the cars onto a siding, and continued the chase on board the engine *Texas*, running backward. Meanwhile, the raiders left two boxcars behind and set fire to the last one in an attempt to burn a covered bridge. But the pursuing engine coupled onto the blazing boxcar and pushed it across the trestle and out of the way. The *General* ran out of fuel and water and the *Texas* soon overtook it. The chase was over and conductor Fuller had won. The Southerners caught and court-martialed eight of the raiders; eight more escaped to their own lines and the rest were held prisoners. It was a wild ride and a wild pursuit, but there was no fear or holding back on either side.

When did the railroad move west?

Even the Civil War did not stop railroad expansion. In 1863, President Abraham Lincoln signed an act authorizing construction of a transcontinental railroad line from the Missouri River to the Pacific Coast. Omaha, Nebraska Territory, was to be the eastern terminus. The Central Pacific Railroad was organized to drive east from Sacramento, California. The Union Pacific Railroad, starting west from Omaha, laid their first rail in July of 1865. Slowed up by the Civil War, only 40 miles of track had been finished two years later. After the war, however, the work went ahead rapidly because of the employment of thousands of ex-soldiers.

Meanwhile, the Central Pacific was having difficulties getting laborers. The Californians preferred to mine for gold, keep stores or run their farms. Finally, the railroad hired thousands of Chinese workers at a low wage. In 1867, they were employing 14,500 laborers, and work progressed. They toiled eastward through the Sierra Mountains. Trestles were built across deep canyons and tunnels were drilled by hand through several mountains. It was a struggle against nature and the weather.

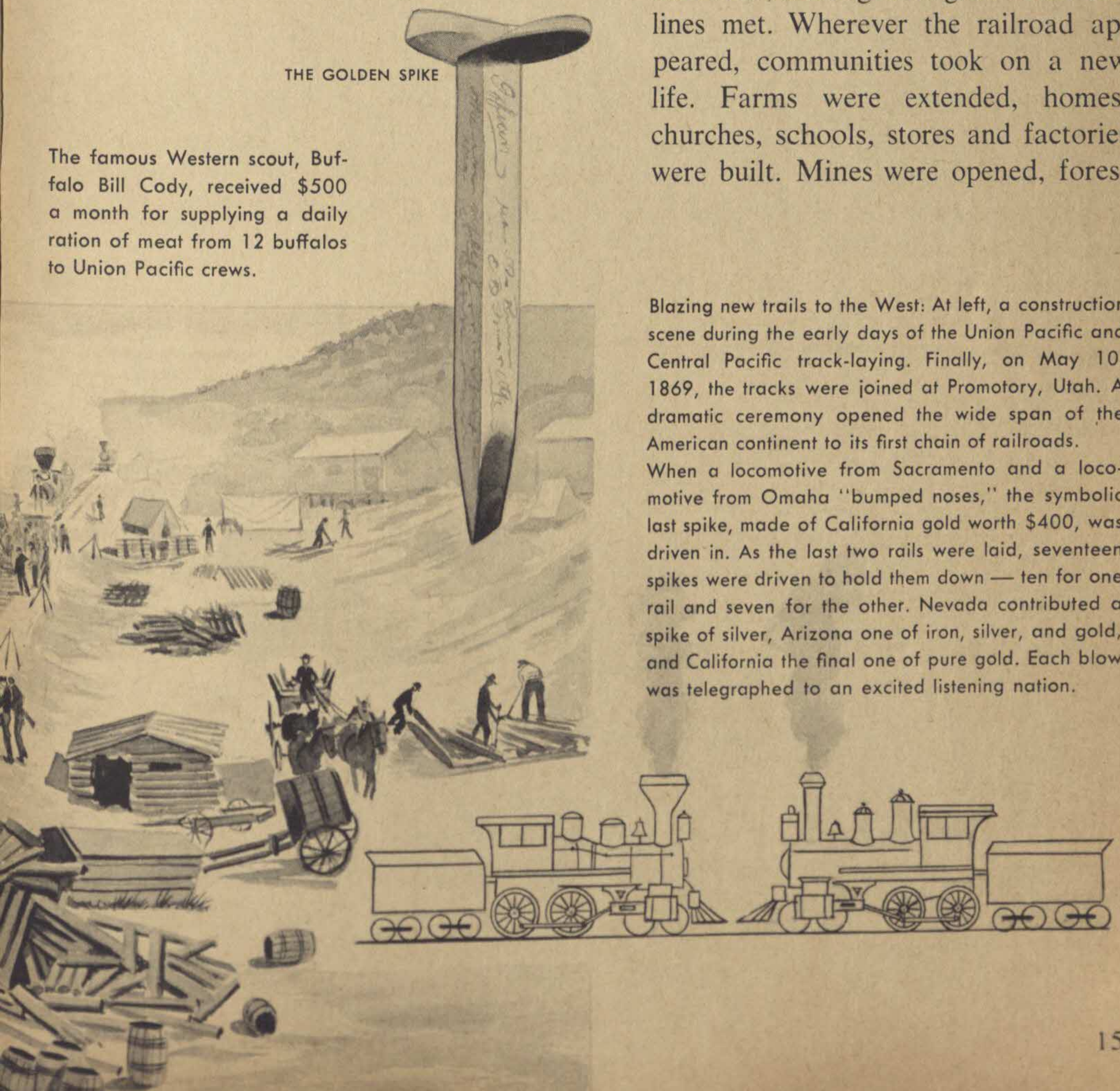
On the plains there was a different kind of struggle. Indians, especially the warlike Sioux and Cheyennes, attacked the track-laying gangs in an effort to halt the march of the iron horse. In



those days, firearms were standard equipment for both travelers and railroad workers. But the power of mechanical progress was too much for the Indians, and they could not withstand it. The rails went down mile after mile and, as the gap between the two lines narrowed, track-laying became a great race. Daily newspaper reports of each railroad's construction were read everywhere with all the interest of a big-league baseball pennant race today. On May 10, 1869, the two roads were joined at Promontory, Utah. The score stood at 1,086 miles of track laid by the Union Pacific and 689 miles by the Central Pacific.

How did railroads help the nation?

The pioneering and wide expansion of the railroads greatly helped the growth and development of the young nation. Population followed the railroads, which were pushed steadily into new and undeveloped areas. Railroads brought more settlers, and for them, the necessities of life. New towns sprang up along the tracks, and big cities grew where rail lines met. Wherever the railroad appeared, communities took on a new life. Farms were extended, homes, churches, schools, stores and factories were built. Mines were opened, forest



THE GOLDEN SPIKE

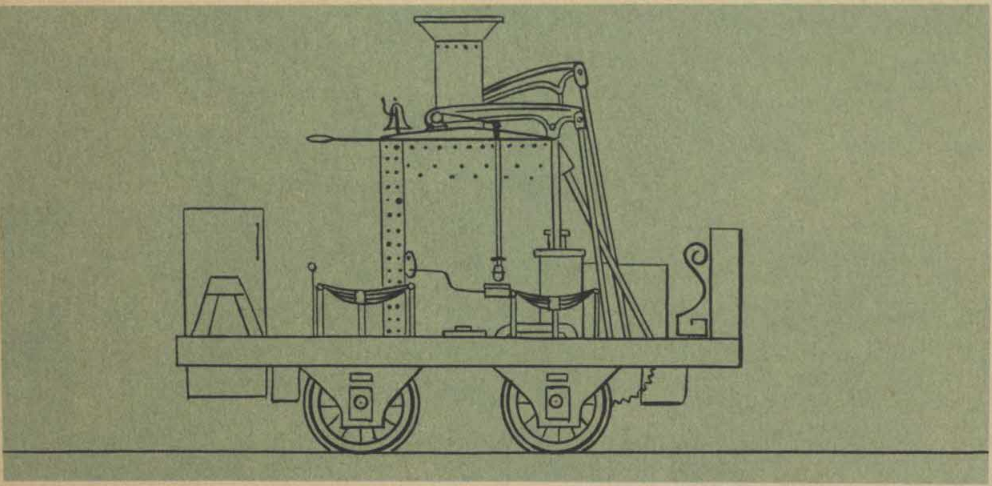
The famous Western scout, Buffalo Bill Cody, received $500 a month for supplying a daily ration of meat from 12 buffalos to Union Pacific crews.

Blazing new trails to the West: At left, a construction scene during the early days of the Union Pacific and Central Pacific track-laying. Finally, on May 10, 1869, the tracks were joined at Promotory, Utah. A dramatic ceremony opened the wide span of the American continent to its first chain of railroads.

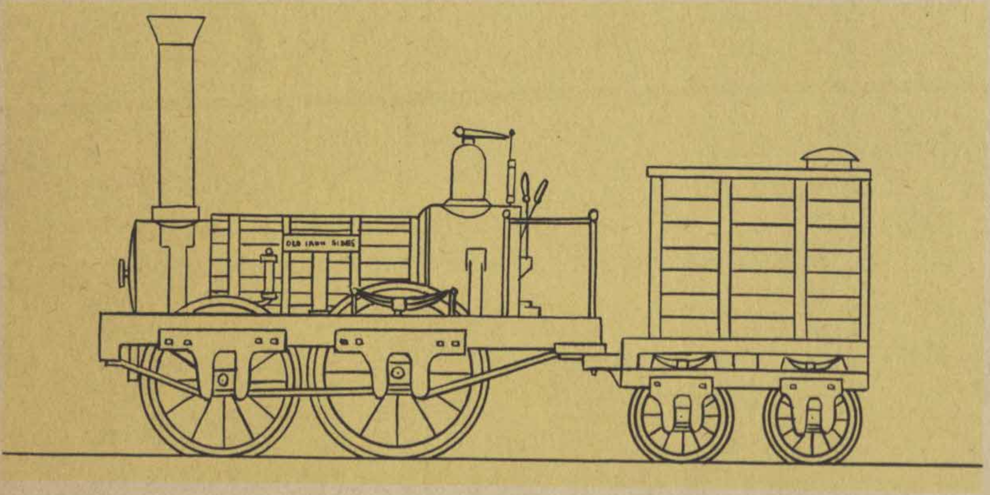
When a locomotive from Sacramento and a locomotive from Omaha "bumped noses," the symbolic last spike, made of California gold worth $400, was driven in. As the last two rails were laid, seventeen spikes were driven to hold them down — ten for one rail and seven for the other. Nevada contributed a spike of silver, Arizona one of iron, silver, and gold, and California the final one of pure gold. Each blow was telegraphed to an excited listening nation.

lands made useful, and cattle brought to consumer markets. The railroads and the new United States of America grew up together.

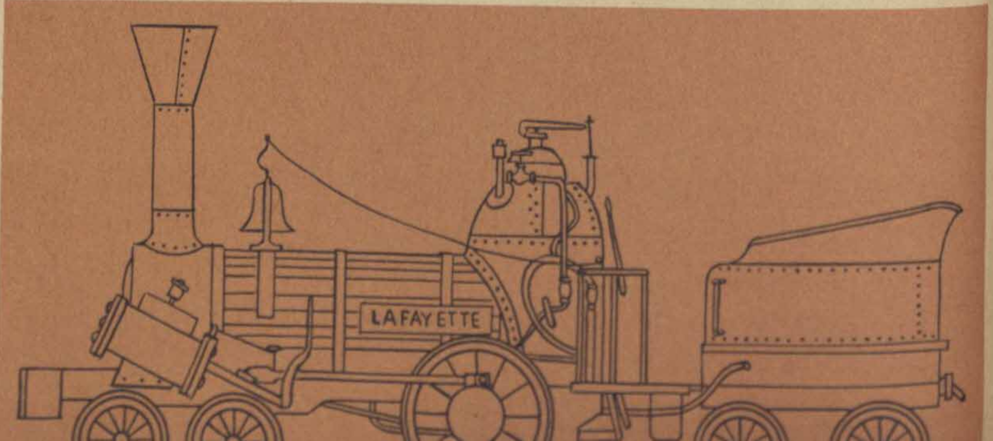
Today, automobiles, buses, trucks, airplanes, river barges and pipelines compete with railroads as a source of public and private transportation. But the railroads still make up the backbone of the transportation of the United States, as do railroads in most other large countries. Railroads carry passengers, freight, mail, express, and baggage. As a matter of fact, they will carry anything that is movable from any station to any other station on the North American continent, in any season of the year.



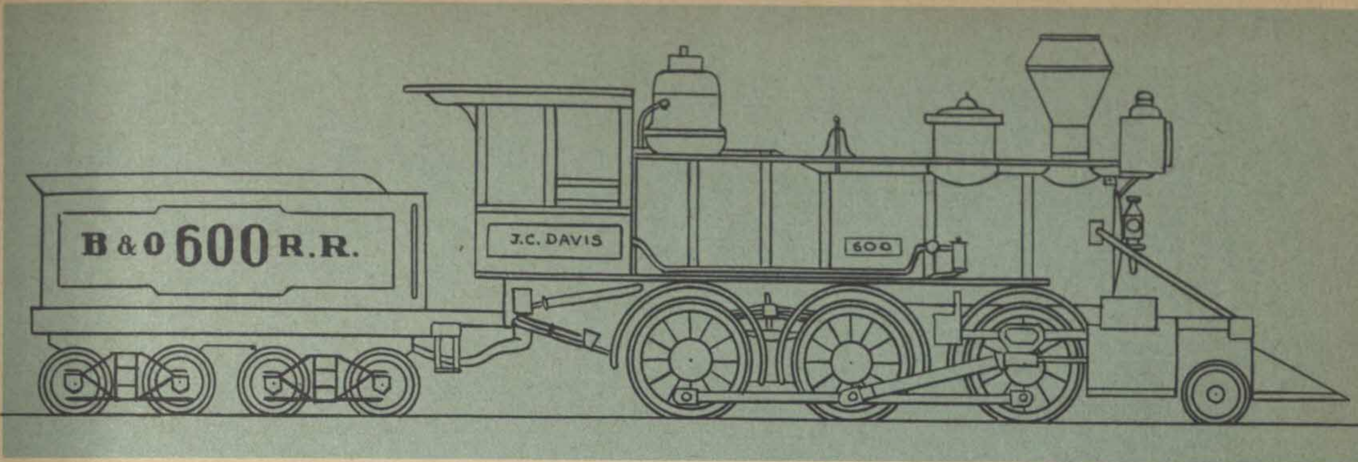
Phineas Davis' prize-winning locomotive went into service in 1832, and is still in operating condition.



"Old Ironsides," a six-ton locomotive, was built by Matthias Baldwin and made its trial run in 1832.



The Norris-built "Lafayette" (1837) was the first engine with a horizontal boiler on the Baltimore & Ohio Railroad.



This first passenger Mogul locomotive in the world won first honors in the 1876 exposition as the finest and largest locomotive built up to that time.

Millions of Horses—Modern Locomotives

Who designed the early American locomotives?

In 1831, a railroad in Baltimore, Maryland, offered a $4,000 prize for the best design for a steam locomotive. Phineas Davis, who had come to York, Pennsylvania, from Europe as a poor boy and found work in a watchmaker's shop, saw the advertisement and set out to win the contest. What really interested Phineas, though, was the steam engine. He built an engine for the contest that would burn coal. It took weeks of hard work. Finally, it was finished, and Phineas named it the *York*.

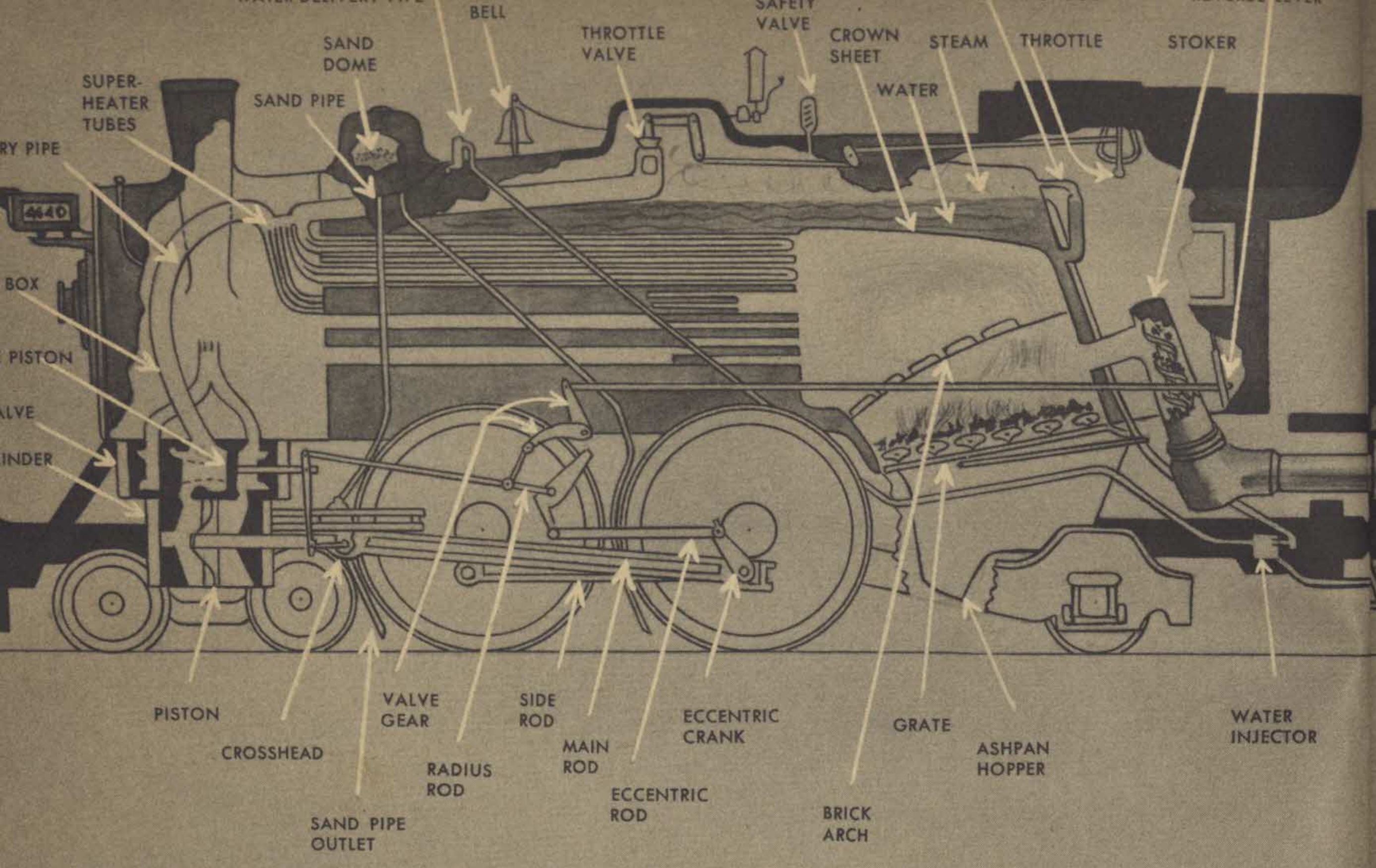
"I believe it's a pretty good engine," he said. "It may even get up enough steam to go fifteen miles an hour." He could not, however, try it out. There were no railroad tracks in York. Phineas carefully took his engine apart, loaded the pieces into an oxcart, and hauled them fifty miles to Baltimore.

Four other engines entered the contest. But Phineas Davis' engine was judged the best. On level track, it would even travel twenty miles an hour. Phineas won the $4,000 as well as a new job. He stayed in Baltimore to build engines for the railroad which gave him the prize.

Phineas Davis was only one of many pioneers in locomotive building. Peter Cooper had already proved the value of the steam engine with the famous *Tom Thumb*. Matthias Baldwin, Horatio Allen, John B. Jervis, Richard Norris, and many others were in this pioneer group of locomotive builders and designers. The early pioneers were followed by other inventors and designers who built larger and larger locomotives that were more and more powerful. The United States still excels in locomotive building.

What types of locomotives do railroads use?

Today's locomotives are great power plants on wheels. They pull long passenger trains at high speeds. They haul mile-long freight trains. Locomotives are designed to do many different kinds of jobs. For example, some are designed for passenger trains which travel from Chicago, Illinois, to the Pacific Coast,



CUTAWAY VIEW OF MODERN STEAM ENGINE.

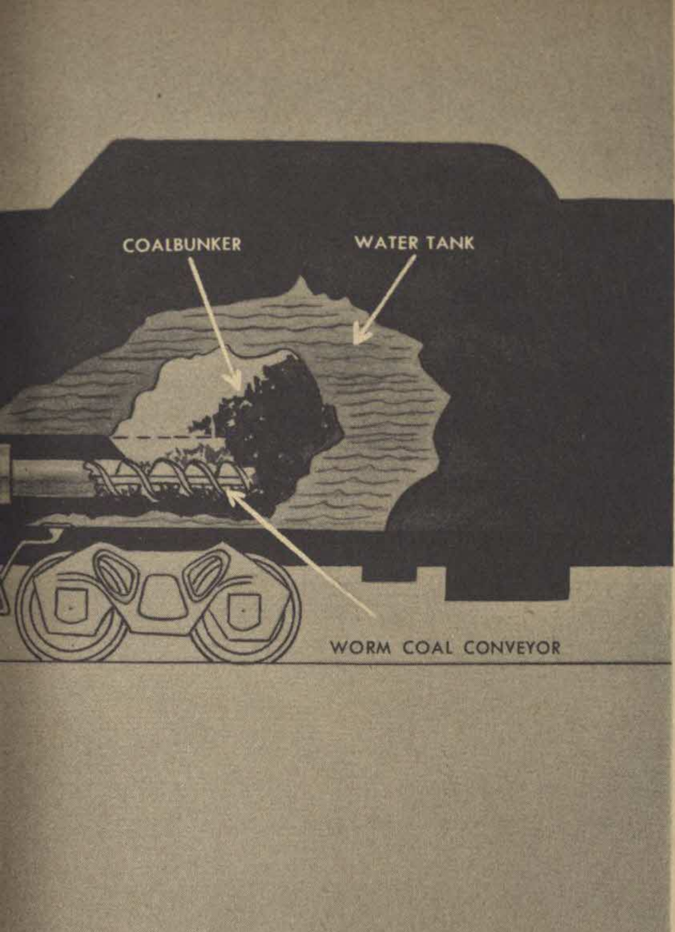
with very few stops. Smaller engines haul "local" trains which travel only short distances and make many stops on the way. Some freight locomotives pull long trains of coal. Others may haul trains of fresh vegetables in refrigerator cars. Many kinds of freight are moved to their destinations at passenger train speeds. On level land, the locomotive can keep up its speed and power without much trouble. In mountainous country, extra power must be available for long, steep grades. Sometimes, in order to increase the power required to pull a train, several locomotives are coupled together and function as one unit.

The jobs performed by today's locomotives would have made Phineas Davis' eyes pop. Of course, the chief job of the locomotive is still to haul a train. Today's locomotive, however, is also the source of power for all the comforts we expect on a train. The locomotive supplies heat and hot water for a whole train of passenger cars, builds up compressed air for the brake system, and does many other tasks.

Railroads use steam, electric, and Diesel-electric powered locomotives. A new type of locomotive developed in recent years is the gas-turbine locomotive. Atomic power for locomotives is under study and experimentation.

What is a steam locomotive?

For more than a century, the steam locomotive was the chief source of power on American railroads. Today, some steam loco-



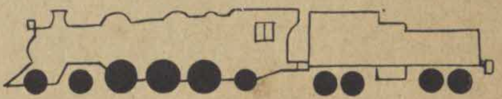
(Courtesy Trains Magazine, Milwaukee, Wis.)

motives continue to do useful work in passenger and freight service.

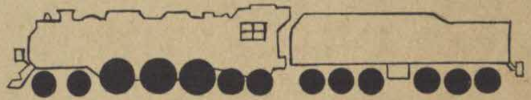
A steam locomotive is basically a simple machine consisting of two parts. First, a firebox and boiler that generates steam and second, the "engine." The engine has cylinders in which steam pressure pushes pistons and driving rods to turn the wheels. The cylinders are located ahead of the driving wheels on each side. Some locomotives have two separate sets of cylinders. Looking at the side of one of these engines, you will see the pilot truck wheels in front, then the cylinder with a set of driving wheels, then another cylinder and another set of driving wheels, then a trailing truck. It is as if two locomotive frames had been put under one boiler. These engines are called *articulated* locomotives

Steam locomotives are classified by the wheel arrangement. A railroader might say to you, "That engine is a 4-6-2." By this, he means that it has two pairs (4) of small wheels in front, three pairs (6) of larger driving wheels, followed by a single pair (2) of small wheels under the cab. This is known as the *White System* of identification. You count the small front wheels (often called the *pilot truck* wheels), then the larger driving wheels, and finally the small ones (the *trailing truck* wheels) under the cab. If either set of small wheels is not used, you designate this with a zero, as in 0-6-2 or 4-6-0.

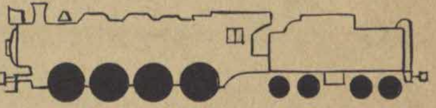
Most steam freight locomotives have smaller driving wheels than have passenger engines. The smaller driving wheels give the locomotive greater pulling power. Large driving wheels on the passenger engine make for greater speed. Pulling power of a locomotive is governed by the number of driving wheels. Count them next time you board a train.



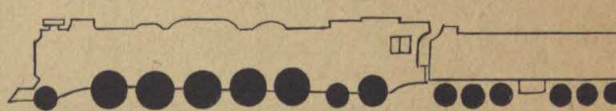
4-6-2



4-6-4



0-8-0



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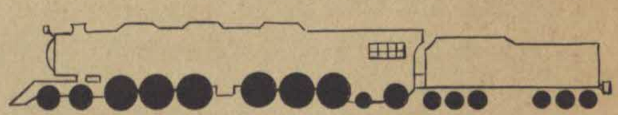

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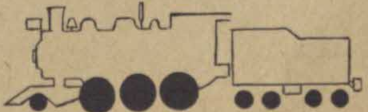

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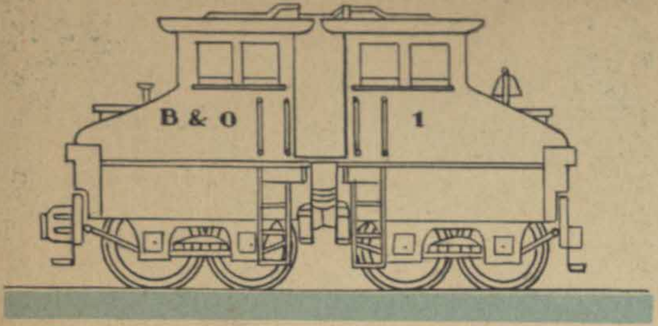
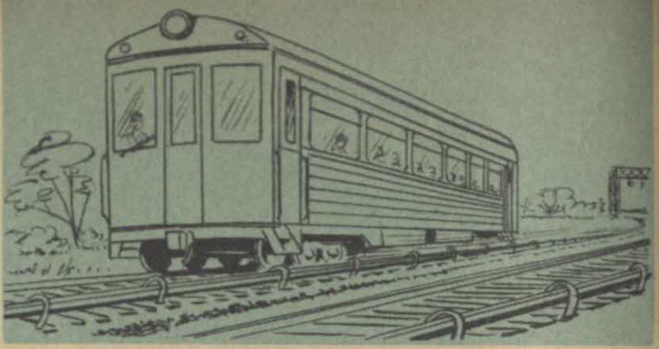
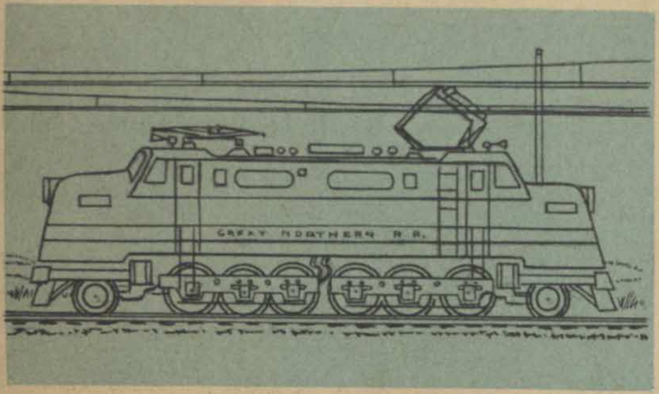





GREAT NORTHERN R.R.

Above left, the first electric locomotive was battery-driven and operated in 1895 in a tunnel under the city of Baltimore. Above right, a typical electric locomotive, which receives its power from a third rail. At left, one that is maintained by power it receives from overhead wires.

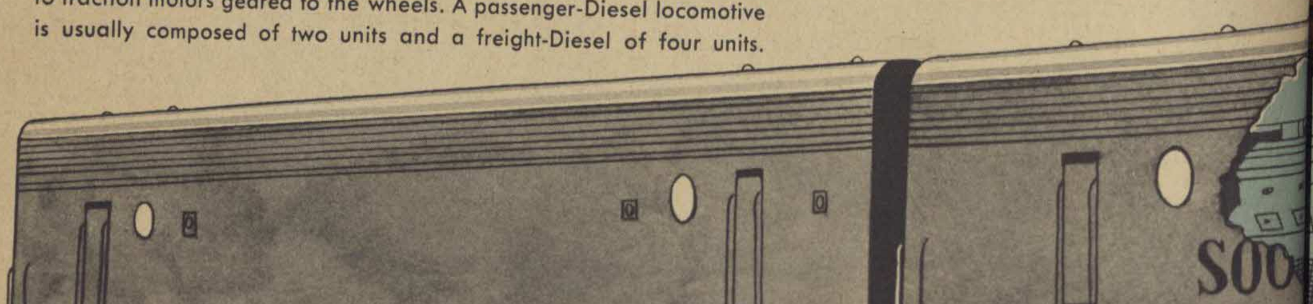
and are used for extremely heavy freight loads in mountainous country.

Nowhere is the romance of railroading felt more than in the cab of a steam locomotive. Most of the controls and gauges used in the operation of the engine and train are located on the boiler head in front of the engineer and fireman. The engineer sits on the right side, the fireman on the left. When the *highball,* a signal for full speed ahead, is given, the engineer releases the air brakes, and inches open his throttle by pulling it slowly toward him. The driving wheels begin to turn. The *throttle* is the lever which starts the locomotive and regulates its speed. To stop the train, he applies the air brakes and closes the throttle. Air brakes are controlled by a small lever near the engineer's right hand. In front and to the right is the reverse lever.

What is an electric engine?

Electric locomotives first went into service in 1895. Today, there are hundreds of electric locomotives in operation in the United States. They are used for heavy trains, both

The cutaway sections show the vital parts of a Diesel-electric locomotive. The Diesel motor in each unit drives a generator which sends power to traction motors geared to the wheels. A passenger-Diesel locomotive is usually composed of two units and a freight-Diesel of four units.



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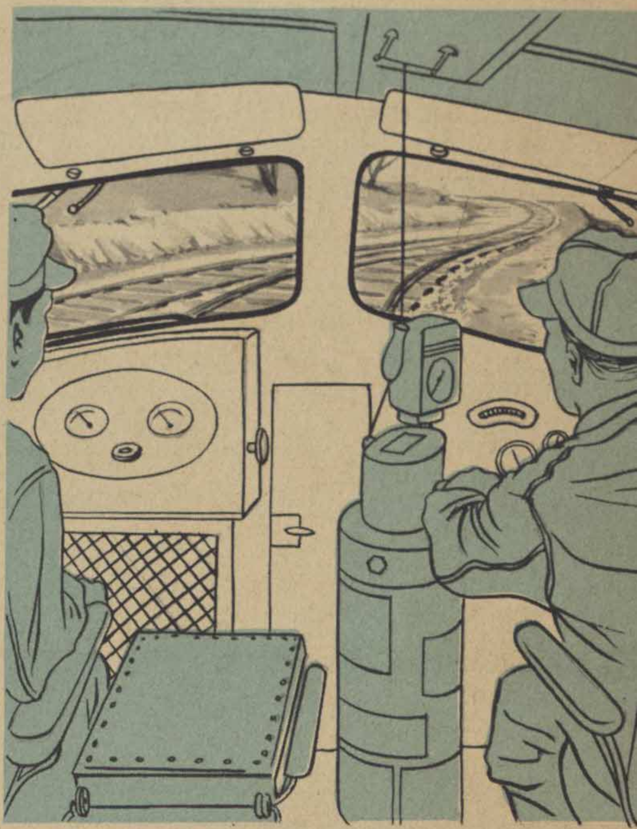
passenger and freight, where tracks are electrified. Electric locomotives are ready for instant service. They pick up speed rapidly. They make no smoke, carry no coal and very little water. Thus, they do not need tenders. They can go forward or backward with equal ease. They do not have to be turned around, as they have a cab for the motorman in front as well as in the back. The electric locomotive gets its power from overhead wires, or from a "third rail," supplied with electricity from a power station.

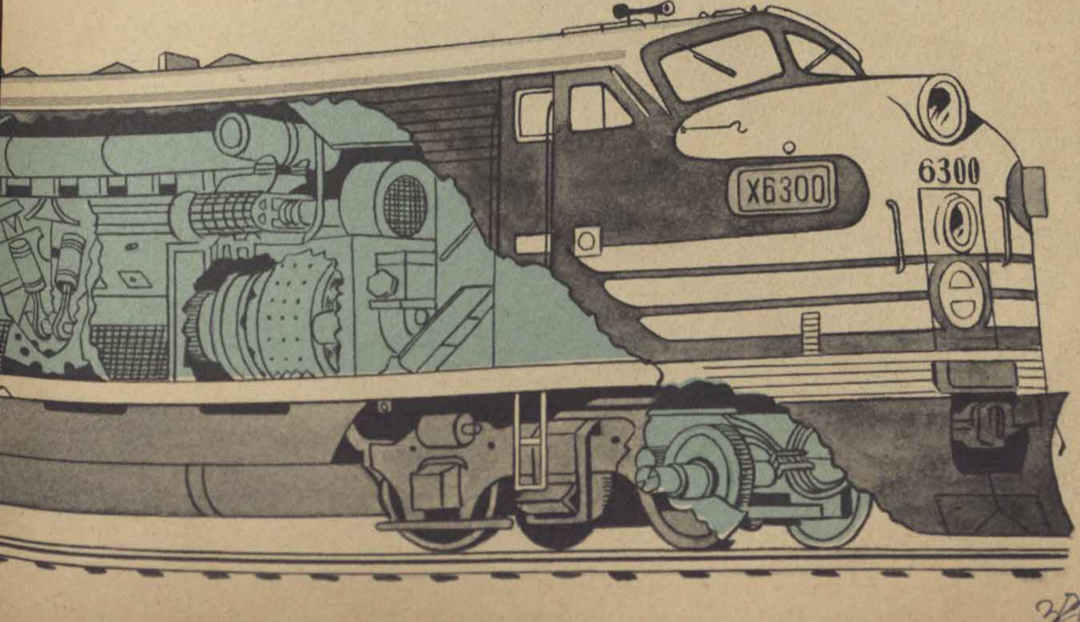
What is a Diesel-electric locomotive?

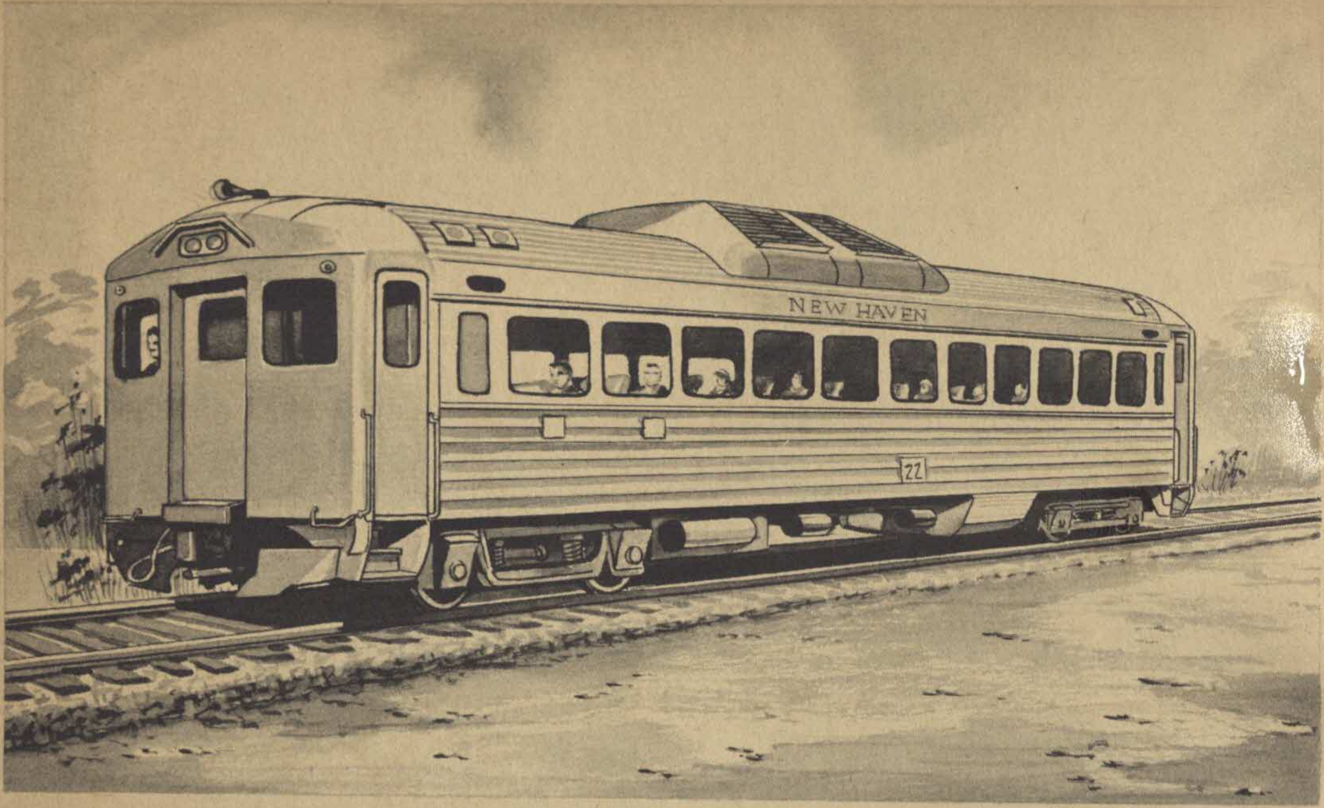
The Diesel-electric locomotive first made its appearance on American railroads in 1925. However, it did not go into regular passenger service until 1934 and into freight service until 1941.

The Diesel-electric burns fuel oil in an internal combustion engine similar to the way automobiles use gasoline. But the Diesel engine drives electric generators. The electric current which they generate is used to operate large electric motors built into the axles of the driving wheels of the locomotive, thus turning the wheels. The entire operation is done very efficiently, and results in an unusually smooth pulling effort and ease of reversing. Diesel-electric locomotives have wheels of smaller diameter than steam engines; forty-inch wheels are standard.



The engineer in the cab o a Diesel, his hand on th throttle. The instrumen panel shows speed re corder, dial indicating th amount of electric curren used, transition-indicato and pressure gauges. Th automatic brake valve i close to the engineer' right hand. On the instru ment panel in front of th fireman are the fuel an water gauges.





A rail-Diesel car, with its own engine, permits considerable flexibility in commuter service. During rush hours, several cars can be coupled together; only one or two need run in non-peak traffic.

Today, there are more Diesel-electric locomotive units in service on American railroads than any other type of motive power. Rail Diesel cars which are self-propelled units, are used for local passenger commuter service on several railroads in the United States. Several cars can be coupled together to handle traffic peaks, while one or two can be used in non-rush hours.

What is a gas-turbine electric locomotive?

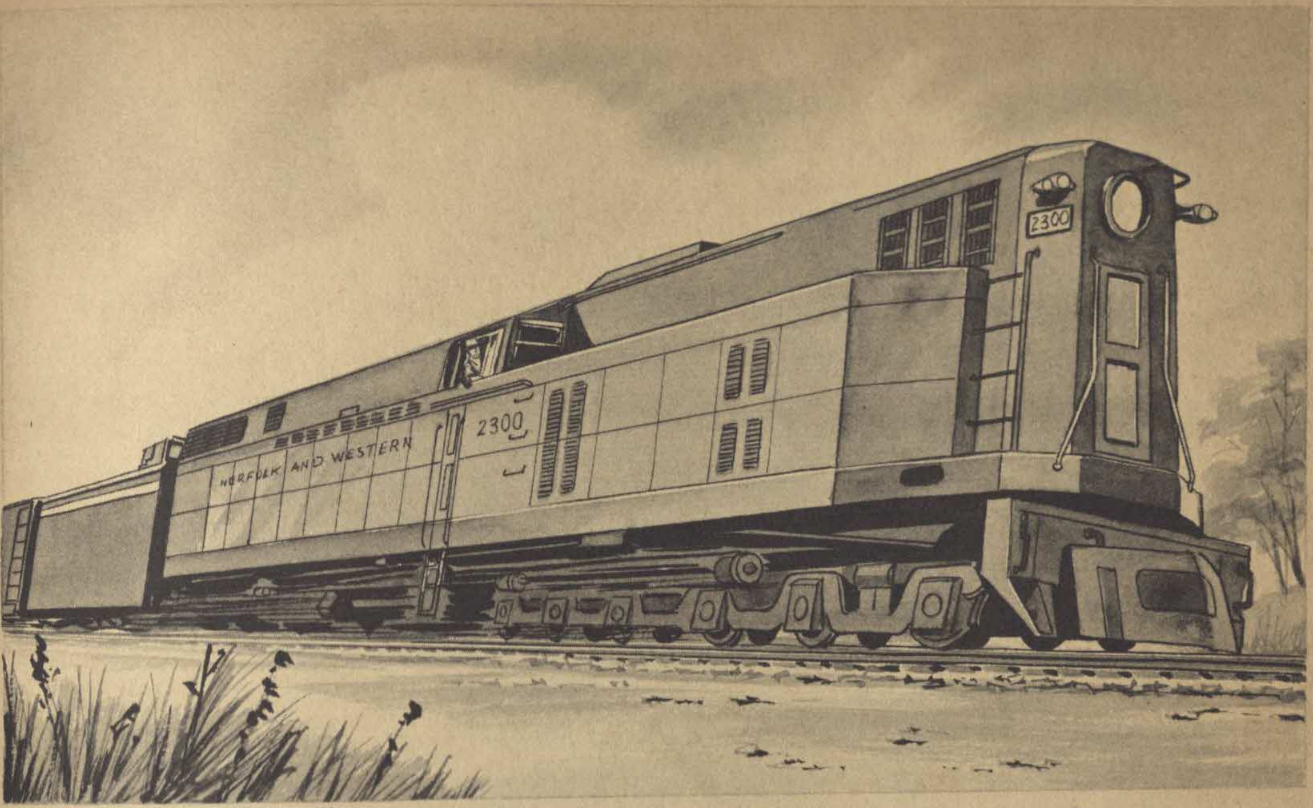
The first gas-turbine electric locomotive was built in 1948. Since that time a number of units have been placed in regular service. Designed especially for fast, long-haul freight service, the gas-turbine burns fuel oil. A turbine-driven compressor powers generators which in turn supply electric power to the motors which turn the wheels. Gas-turbine electric locomotives resemble the Diesel-electric type in outward appearance, but require an oil tender that is similar to the steam type.

An engine that moves cars about in freight yards or passenger terminals, transferring them from one track to another, is known as a *switcher*. Steam, electric, and Diesel-electric locomotives are used in switching service.

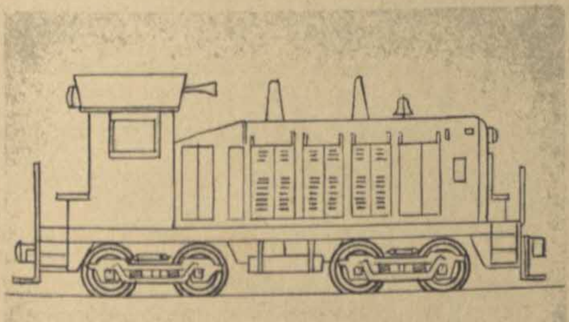
Railroadmen are studying the possibilities of nuclear-powered locomotives. Whether atomic power would be more economical and efficient than present types of motive power is a question which only further research can answer.

Who operates trains?

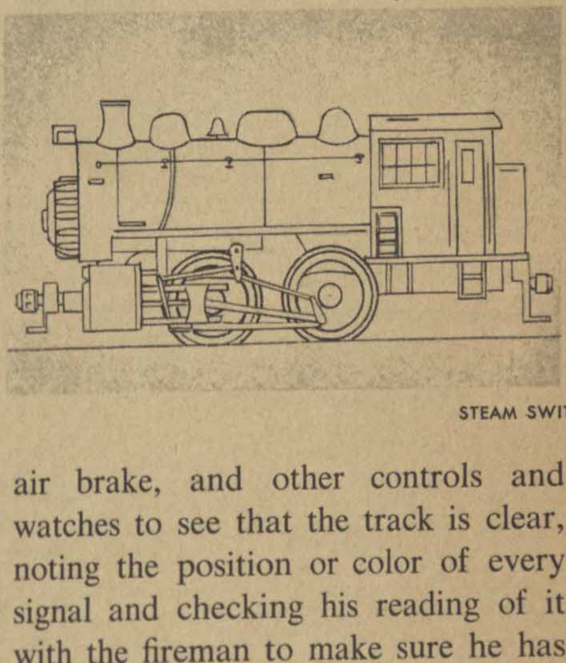
Trains are operated by train crews, usually consisting of four or more men — a conductor, one or more brakemen, a locomotive engineer, and



This is one of the largest coal-burning gas-turbine electric locomotives in the world. With loaded tender, it weighs 586 tons and it is over 161 feet long. The wheel arrangement is 6-6-6-6 and its 4,500 horsepower gets it to a top speed of about 60 M.P.H.



DIESEL-ELECTRIC SWITCHER



STEAM SWITCHER

a fireman. The engineer and fireman are known as the engine crew. The *engineer* (or *engineman* as he is sometimes called) is responsible for the efficient and safe operation of his locomotive. Before each run, he carefully inspects the engine and checks the supply of fuel, water and other items needed for the trip. En route, he operates the throttle, air brake, and other controls and watches to see that the track is clear, noting the position or color of every signal and checking his reading of it with the fireman to make sure he has observed it accurately. He must obey signals instantly. If he should delay in applying his brakes when approaching a "stop" signal, for example, his locomotive might go thundering into the rear of a train ahead. At the end of the run, he checks the engine again and makes out a report on any mechanical defects, such as sticking brakes, that need attention. In addition, he states the reasons for any unscheduled stops or delays.

The *fireman* got his name in the day when all locomotives burned wood or coal and had to be stoked by hand. Most, if not all, locomotives now in use are mechanically stoked, oil burning or electric, but he still has the duty of regulating the flow of fuel by operating valves. In addition, every fireman must be prepared to take over at any moment if the engineer should suddenly become sick or disabled. The fireman's ability to take emergency charge of the train may be all that saves it from disaster. He also has to watch the engine gauges, and must be able to detect engine trouble. Keeping a lookout for obstructions on the track and for wayside signals is another important part of his job. He, as well as the engineer, is held responsible for any accident due to failure to obey signals. The duties of the conductor and brakemen are described later in the book.

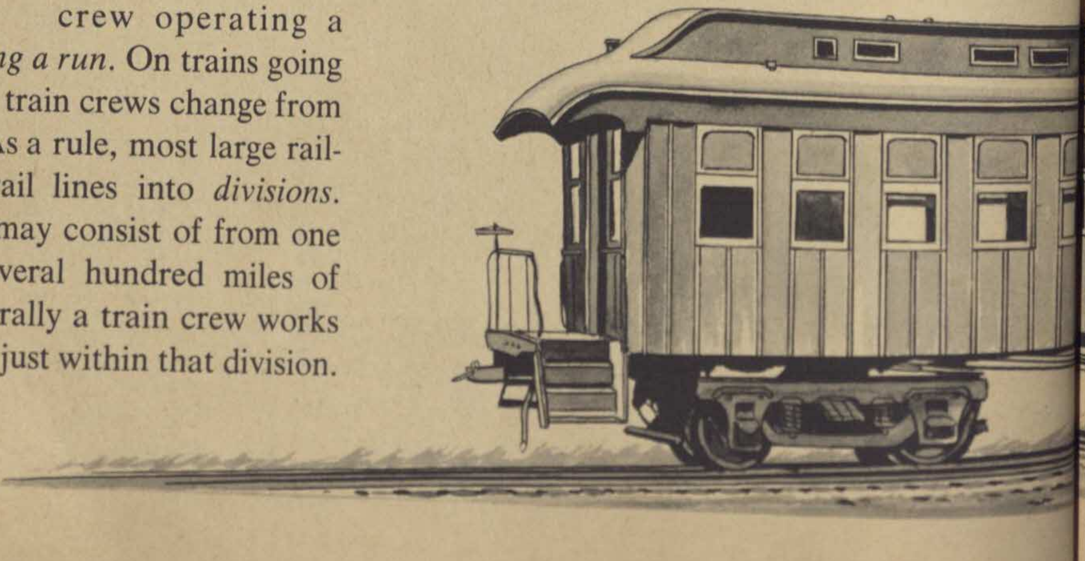
What is meant by a "run"?

A *run* is a train's or engine's journey between two given points. The men or crew operating a train are *making a run*. On trains going long distances, train crews change from time to time. As a rule, most large railroads divide rail lines into *divisions*. Each division may consist of from one hundred to several hundred miles of track, but generally a train crew works or makes a run just within that division.

Who was the most famous engineer of all times?

There have been many heroic engineers in the history of railroads, but the best known is Casey Jones. We all have either heard or sung the "Ballad of Casey Jones." But Casey Jones was a real person. He was an engineer employed in the 1890's on the Mississippi Division of the Illinois Central Railroad. His real name was John Luther Jones, but to distinguish him from other men named John Jones working on the railroad, his friends nicknamed him "Casey" because he hailed from Cayce, Kentucky.

Casey Jones was typical of all good railroad engineers. He loved his engine and took great pride in having his train arrive on time. Unfortunately, Casey was killed in a wreck near Vaughan, Mississippi, on the night of April 29, 1900. His train, the *Cannonball Express,* was rolling at 60 miles an hour when it crashed into the rear end of a freight which had not cleared the main track. After Casey's death at the throt-

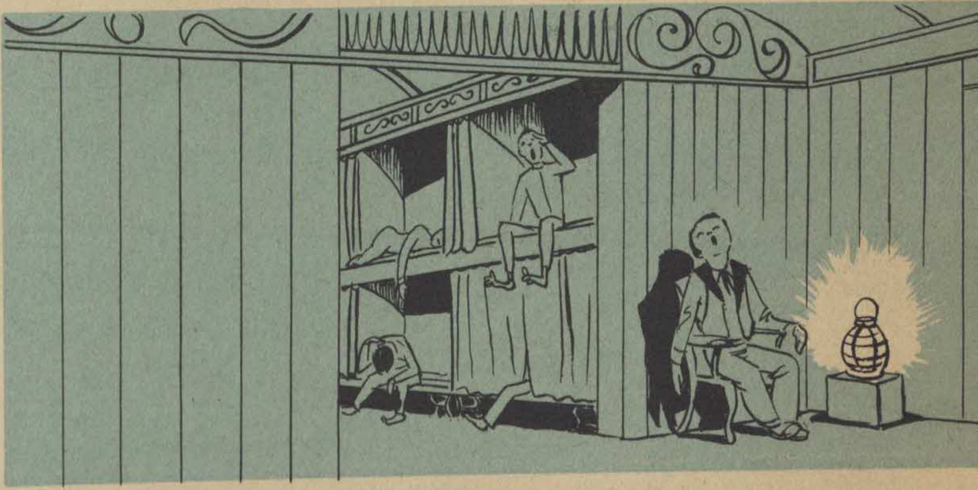


tle of his engine, Wallace Saunders, an engine helper who knew and loved the daring engineer, made up the best known folksong of the rails. But, the reason Casey Jones became famous was the fact that he established the tradition that an engineer stay with his engine in danger just as the captain of a ship is the last to leave a sinking ship. Thus, when you sing the "Ballad of Casey Jones," you are singing about *all* the brave engineers who have given or risked their lives and have stuck to their jobs in the face of danger.

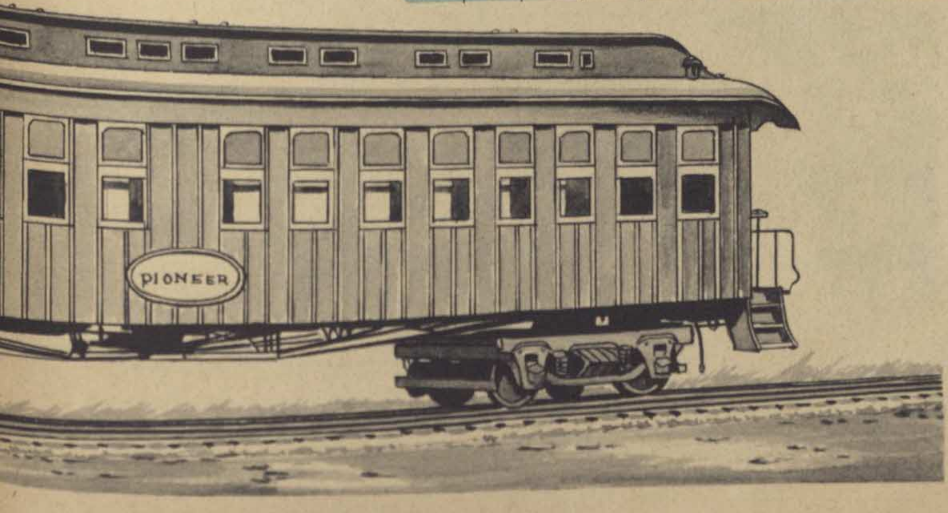
Traveling by Rail

How did George Pullman improve passenger travel?

Imagine traveling in a sleeping car with bunks three tiers high, heated by a pot-bellied stove and lighted by candles. While riding one of these luxury "sleeping cars" in the early 1850's, George M. Pullman tossed and turned in his hard, springless bunk. He just could not sleep. The car was only a day coach fitted with hard bunks. The car jerked, the candlelight flickered, and the



Sleeping cars of the 1850's, although a far cry from today's conveniences, were an improvement over the discomfort of sitting up all night in the coaches.



Pullman's "Old No. 9" was a remodeled wooden day coach, and made its first run in 1859. The "Pioneer," Pullman's first real sleeping car, built from scratch, cost $20,000 to construct. It was placed in service 1865.

cold wind whistled through the cracks around the windows. The coarse blanket did not ease his discomfort.

George Pullman found himself thinking that night about a car which would give passengers real comfort. Finally, in 1864, Pullman was able to build his first real sleeping car. By that time, he was a successful Chicago contractor. Pullman spent all his money building the sleeping car he had dreamed about. He called it the *Pioneer*. The car and Mr. Pullman both became famous in 1865 when the car was first used to carry the body of President Lincoln to his final resting place in Springfield, Illinois.

Within three years, Pullman had a number of cars in operation on three railroad lines. Pullman steadily added improvements to his cars such as steel underframes, enclosed vestibules, and hot water heat. He contributed greatly to the improvement of railroad passenger equipment. Nonetheless, modern train facilities are a far cry from those of Pullman's day.

What are the three types of passenger service?

The rails offer three basic types of passenger service: *commutation*, *local*, and *through*. Commutation service is provided for people who live in the suburbs and work in nearby cities. Commuter passengers usually buy multiple-ride tickets. Local service trains stop at nearly all stations on their routes to service passengers who ride for only a few stops. Through, or express, trains operate between larger cities with few or no stops at smaller towns in between.

What is the "consist" of a modern passenger train?

The *consist* of a passenger train is the number and type of cars that make it up. Behind the locomotive of through passenger trains are the express, baggage or mail cars, known as the "head-end" cars. Behind these usually are coaches and then parlor cars and sleeping cars. The dining cars and club cars are usually near the center of the train and the observation cars are at the rear. There are individual variations of this basic arrangement. Some trains are entirely coach trains, with special club and dining cars, and others are entirely made up of sleeping cars.

Passenger cars range in length from about 60 feet to 88 feet, the average length being about 72 feet, over-all outside measurements. Most newer cars are 85 feet in length. Many passenger trains are *streamlined*, which means that the train is especially built of strong lightweight metals with the shape of all cars conforming to each other. The train presents an unbroken line from the head end to the rear of the last car.

Who are the members of a passenger train crew?

The members of a regular passenger train crew include the engineer, fireman, conductor and one or more brakemen. The *conductor* is in charge of the train. He sees that the members of the

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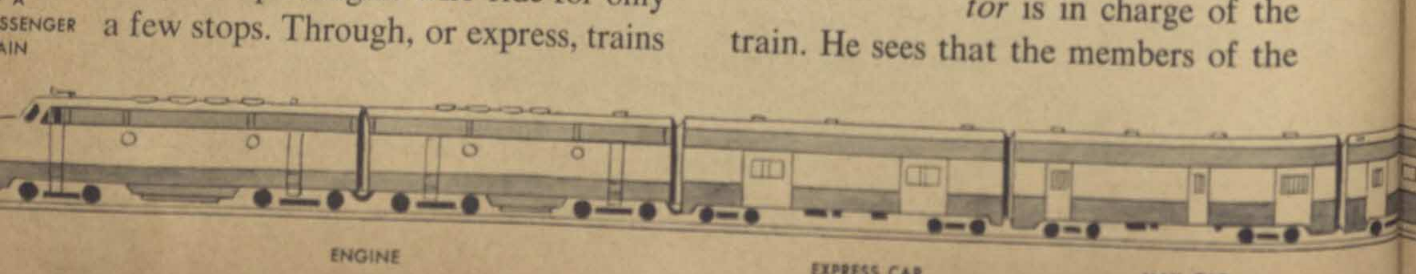
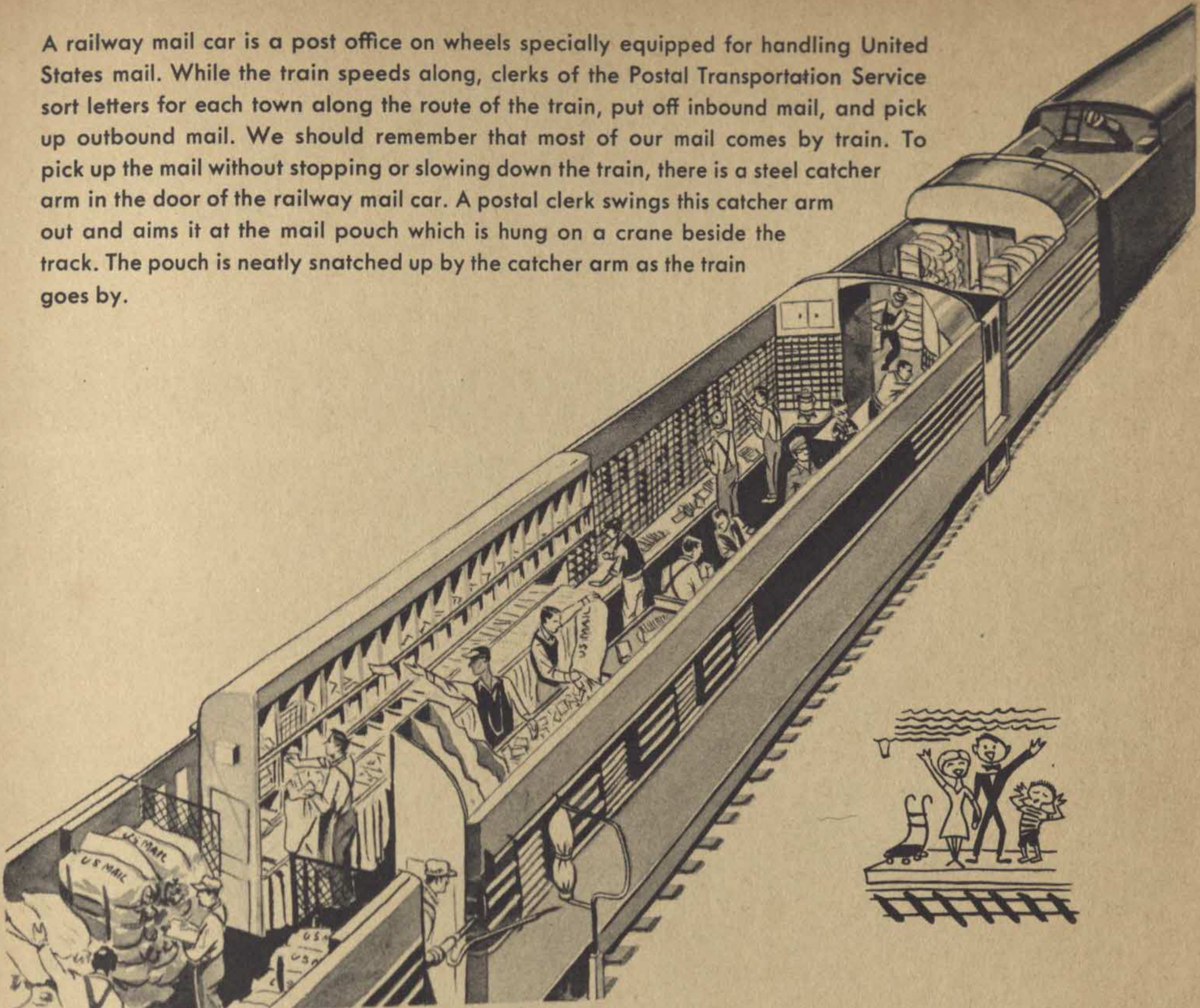


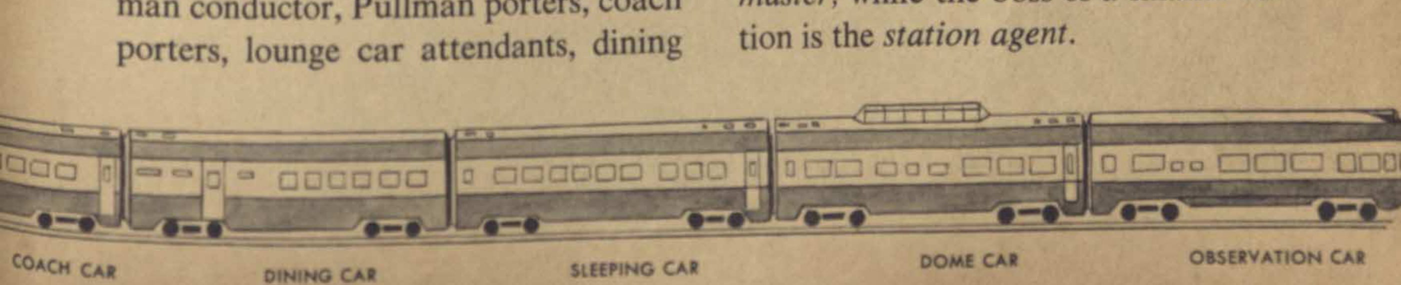
A railway mail car is a post office on wheels specially equipped for handling United States mail. While the train speeds along, clerks of the Postal Transportation Service sort letters for each town along the route of the train, put off inbound mail, and pick up outbound mail. We should remember that most of our mail comes by train. To pick up the mail without stopping or slowing down the train, there is a steel catcher arm in the door of the railway mail car. A postal clerk swings this catcher arm out and aims it at the mail pouch which is hung on a crane beside the track. The pouch is neatly snatched up by the catcher arm as the train goes by.

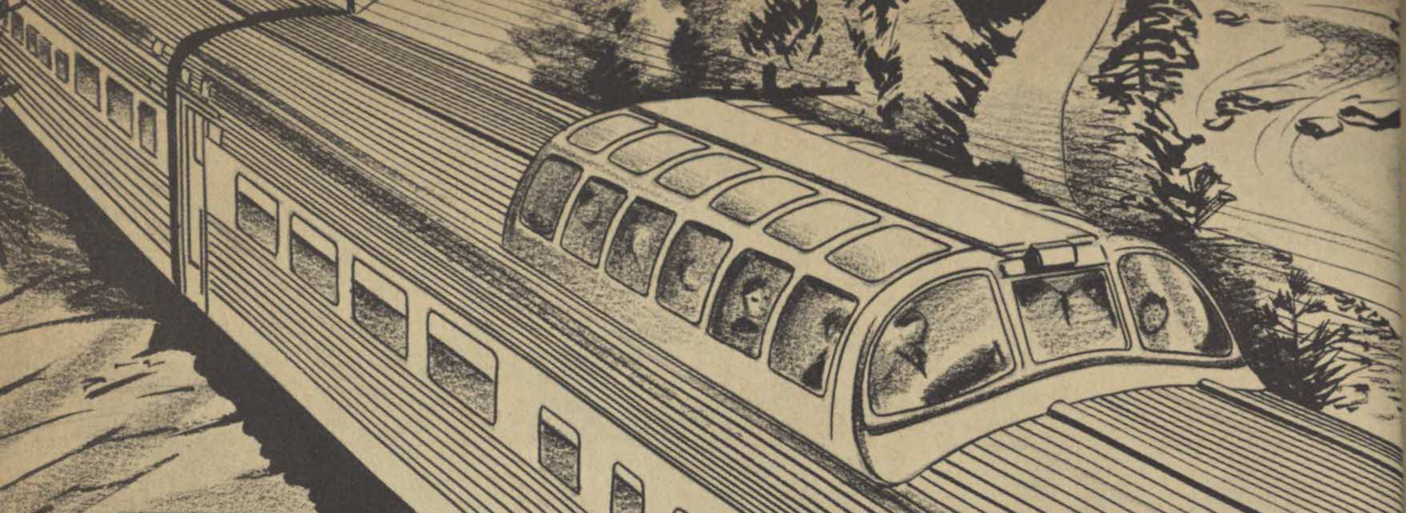


train crew do their work properly, and that all orders concerning the movement of his train are carried out. He is in charge of collecting tickets, collecting fares, calling stations, and generally assisting the passengers. Passenger *brakemen* (often known as *trainmen*) perform many of these same tasks, look after the needs of passengers, and may help to collect tickets.

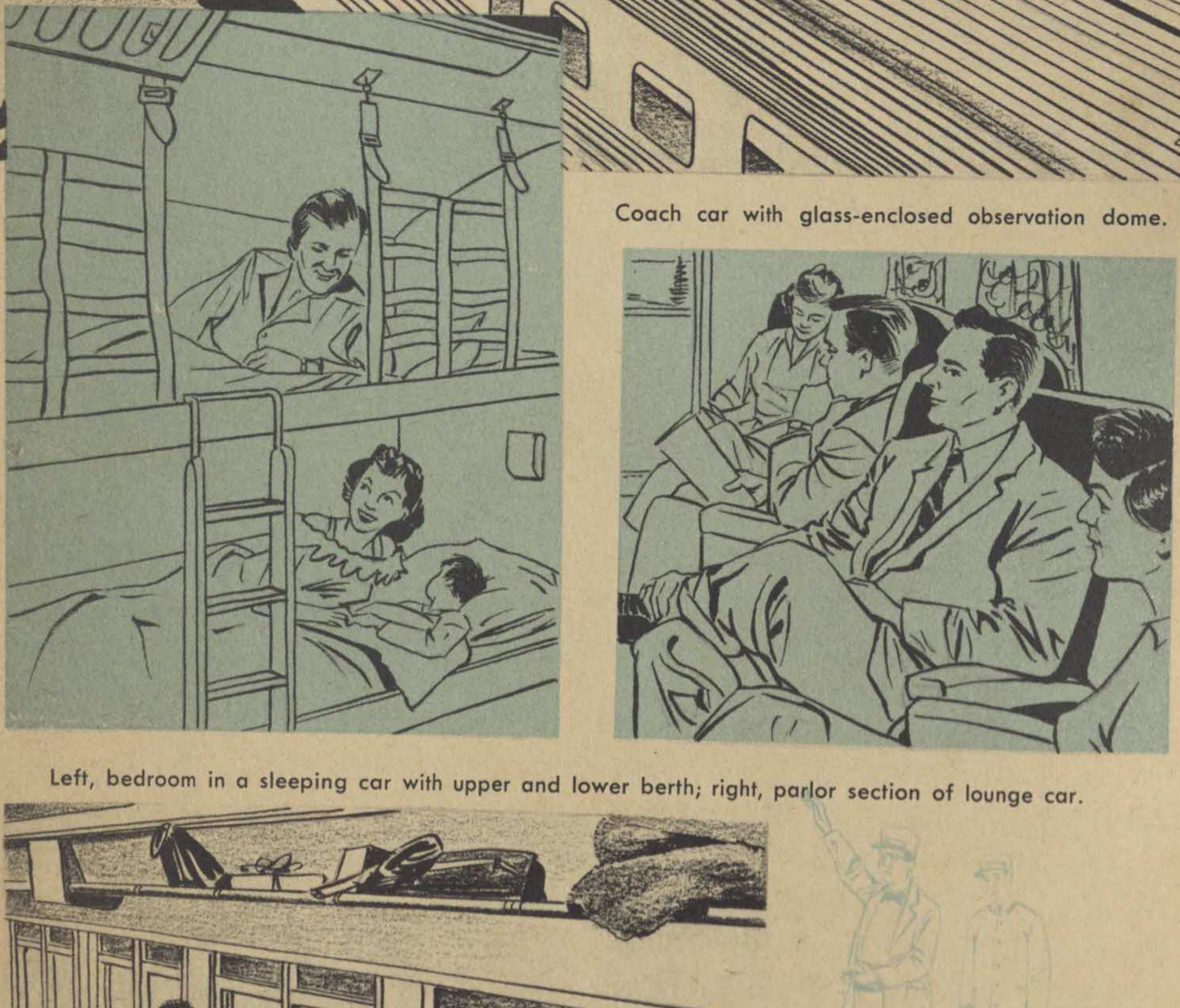
Besides the regular train crew, there are other workers on a passenger train. There may be baggagemen, express messengers, railway postal clerks, Pullman conductor, Pullman porters, coach porters, lounge car attendants, dining car stewards, cooks, waiters, and, on some trains, a stenographer and a stewardess.

Most of the railroads' business with the traveling public is carried on through *passenger stations* located in cities and towns throughout the country. In the cities, these stations may cover several city blocks, while the ones in the country are usually only small buildings. Some stations have lunch rooms, dining rooms, waiting rooms, newsstands, station platforms, ticket offices, etc. In charge of a big station is the *stationmaster,* while the boss of a smaller station is the *station agent*.





Coach car with glass-enclosed observation dome.



Left, bedroom in a sleeping car with upper and lower berth; right, parlor section of lounge car.

CONDUCTOR
AND PORTER

Coach car seating 72 persons; its reclining seats can be tilted back for resting or sleeping.

Dinner, served in the diner, is a real delight prepared in the dining-car kitchen.

Railroads Deliver the Goods

What is a railroad company's most important job?

When you think of railroads, you very likely think first of passenger trains, because you become a passenger yourself whenever you get on a train. But the most important job that railroads do is transporting quantities of freight so large that you can hardly imagine them. Suppose there were 100 loaded freight trains each 3,500 miles long. Each one would reach from Maine to California. American railroads transport that much freight in a year. Or put it another way: Counting tons moved one mile, or ton-miles, United States railroads carry almost as much freight between cities as all the trucks, all the barges, all the lake boats, all the pipelines, and all the airplanes combined.

What are some different kinds of freight cars?

There are boxcars, flat cars, tank cars, refrigerator cars, gondola and hopper cars, stock cars, and specially designed cars for carrying heavy machinery and various products such as ores, pulpwood, acids, sulphur, chemicals and gases. Freight cars vary in length from 24 feet to 75 feet, the average length being about 43 feet, over-all outside measurement. But all freight cars, regardless of what line owns them, are built to meet certain standards agreed upon by all railroads. All cars couple together, brake together, and run together. Even the ladders, steps, and hand brakes are always in the same place. Thus, any car meeting interchange standards set up by the railroads through the Association of American Railroads can go anywhere in any train of any railroad line on the North American continent.

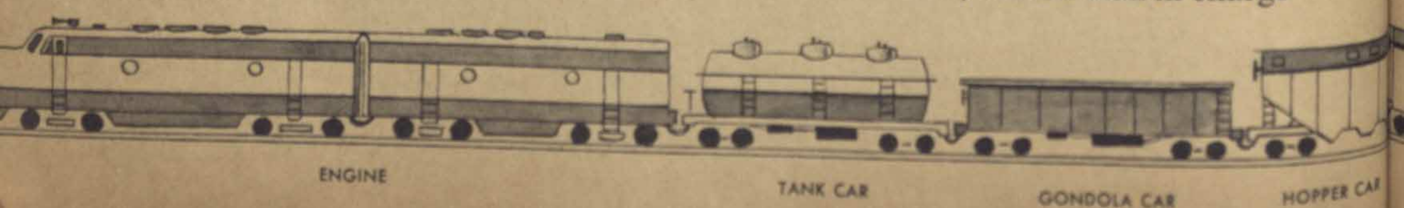
Who forms the crew of a freight train?

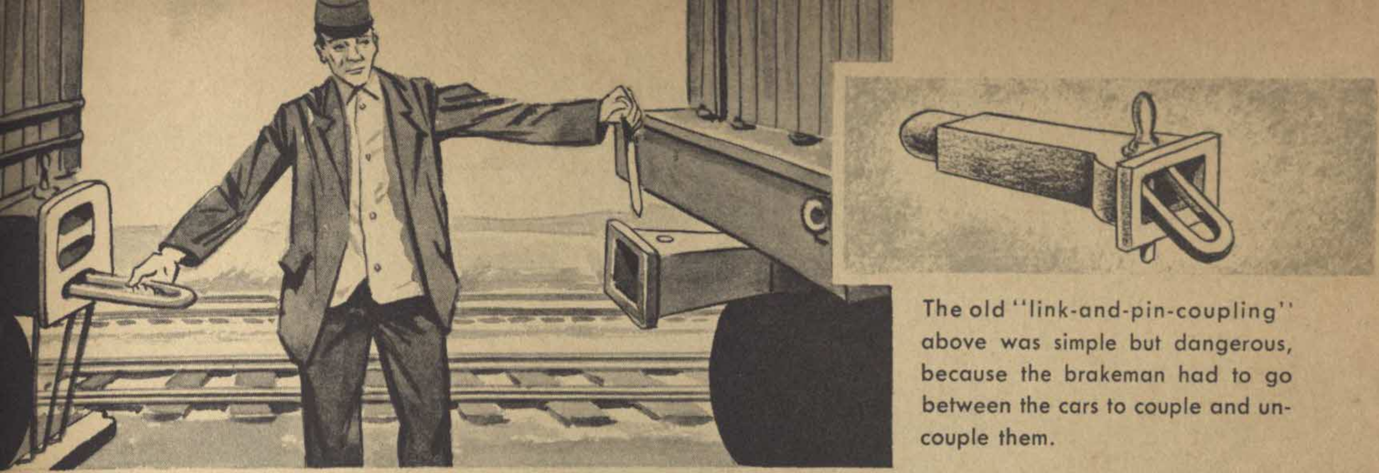
The crew of a freight train usually consists of a conductor, a locomotive engineer, a fireman, and at least two brakemen or flagmen. As in passenger service, the conductor is in charge of the train. He has to assure himself that all members of the crew understand the train orders and that the train has been thoroughly inspected. He must also check the waybills, which tell the destination of each shipment, and know what cars are to be cut off the train at each switching point. As he rides along in the caboose, he is required to enter on appropriate forms the number of the cars, their contents, times of arrival and departure, delays, and such other information as the individual railroads may require. He also keeps a lookout for signals and train orders at stations, and may spend part of the time riding in the cupola on top of the caboose so that he can observe the train operations.

As previously stated, freight trains usually carry at least one brakeman and sometimes more. One of them, the rear brakeman or flagman rides in the caboose. It is his job to protect the rear of the train from being run into during stops or delays. When a stop occurs between stations, he goes back along the track on foot and signals by waving a flag or "starting the fireworks." This means putting a lantern or red flare by the track or placing a torpedo on the rail, where it will explode when an oncoming locomotive hits it. This tells the engineer that there is a train ahead. As you will learn later, on almost all busy lines, automatic signals protect the train until it proceeds into the next "block." The flagman's signals are merely an extra safety precaution. The "head brakeman" rides in the locomotive cab. During stops he attends to the work of picking up or setting off cars, detaches the engine from the train for the purpose of taking on fuel and water, and inspects the head of the train. He protects the train by flag when necessary under emergency operating conditions. Other duties of the freight brakemen include keeping a sharp lookout for smoke from hotboxes — axle bearing or wheel bearing — or other signs of trouble on the train, signaling from one end of the train to the other, setting hand brakes, coupling and uncoupling cars that are set out or picked up along the way, and throwing switches.

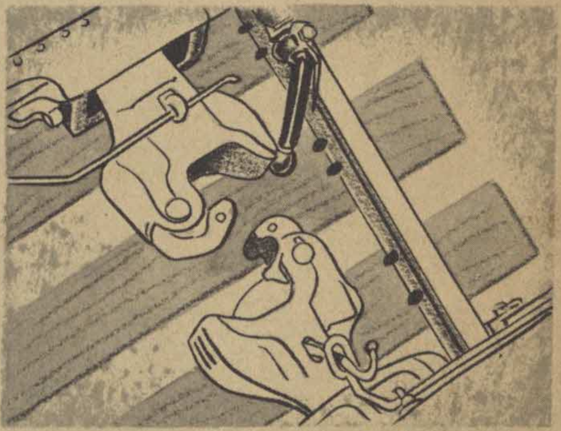
The railroad cars are fastened by automatic couplers which are like the fingers of two hands that come together and lock in a firm grip. When the brakeman moves a lever on the car, the coupler will open so that the car can be pulled away. This means that the brakeman does not have to go between the cars to couple or uncouple them.

There are stations for freight as well as for passengers. The size of a freight station depends upon the amount of business handled, but the man-in-charge


CONSIST OF A FREIGHT TRAIN



The old "link-and-pin-coupling" above was simple but dangerous, because the brakeman had to go between the cars to couple and uncouple them.



The modern coupling works automatically after the brakeman moves a lever on the side of the car.

is always a *freight agent*. The floor of the freight station and its platforms are usually the same height as the freight-car floor, so that hand trucks can move easily between the station and the car. Many of the things that we buy in stores come through the local freight station.

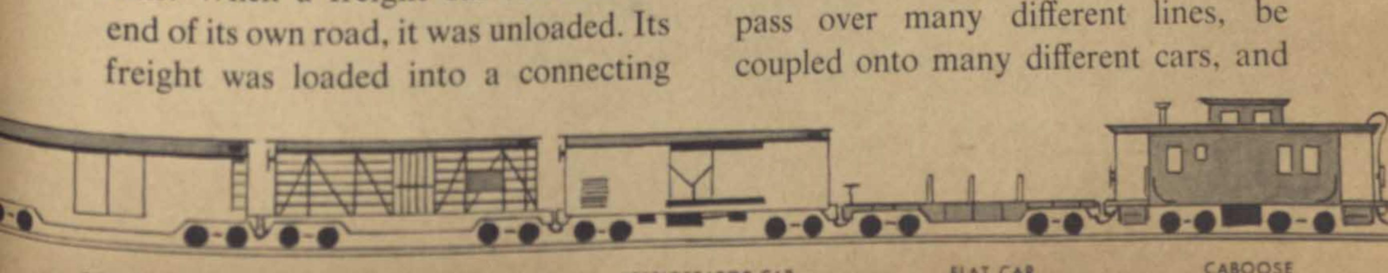
What is the interchange system?

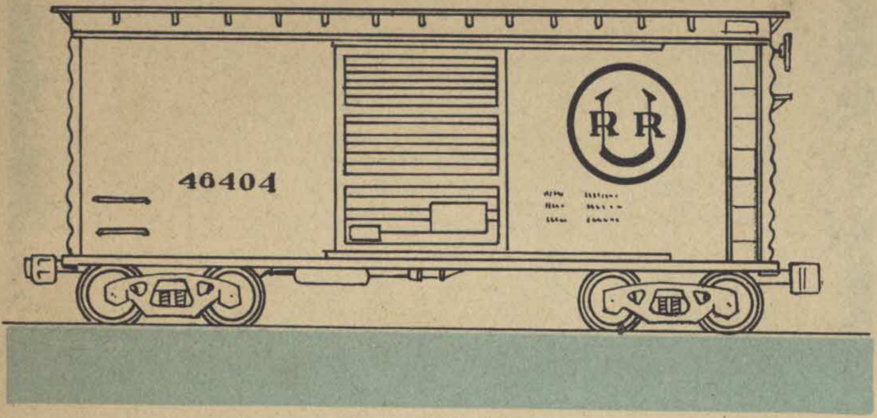
Stand alongside any railroad track and watch a long freight train rumble by. Each car seems to be owned by a different railroad. The *symbols* or *heralds* (owners' trademarks) read "Missouri Pacific," "Great Northern," "Erie," "Rock Island," "New York Central," "Santa Fe," "Wabash," "Union Pacific," and many more.

This *interchange system* of our freight cars is one of the marvels of American commerce. It is a truly amazing example of industrial cooperation. Let us see how it works, and how they keep track of all these cars. It seems next to impossible.

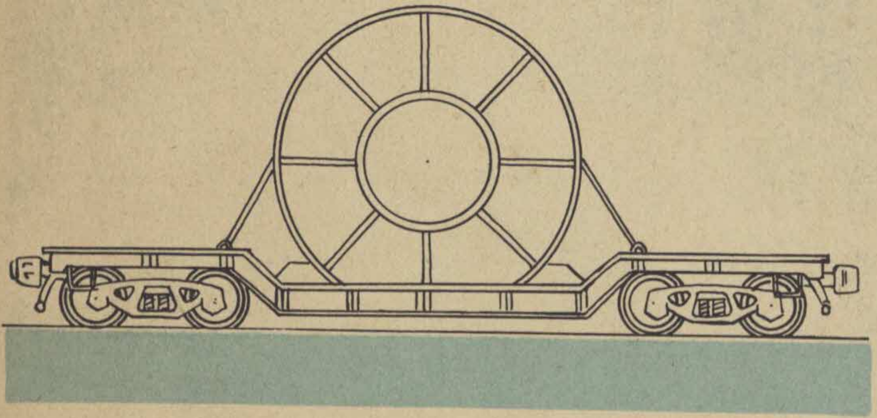
Early freight cars were stay-at-homes. Each railroad kept its cars on its own rails. When a freight car reached the end of its own road, it was unloaded. Its freight was loaded into a connecting road's car. On long-distance hauls, transfer took place many times. Freight shipments were slow and costly.

Working together, the railroads developed an interchange system. As we have already read, all freight cars on the North American continent are standardized. This enables a freight car to be loaded, for example, in the Pacific Northwest and to travel to Florida without unloading en route. After unloading in Florida this car is filled and rolls back to its original owner. Or it may be loaded in Florida with goods needed in Portland, Oregon. During its run it may pass over many different lines, be coupled onto many different cars, and

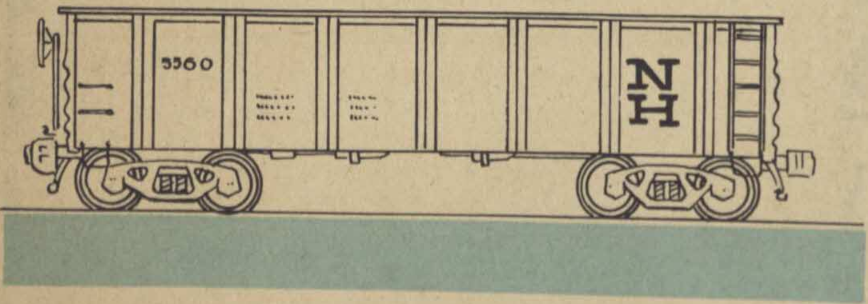




The completely housed-in boxcars usually have one large sliding door on each side, and carry almost anything that requires protection from theft or weather.



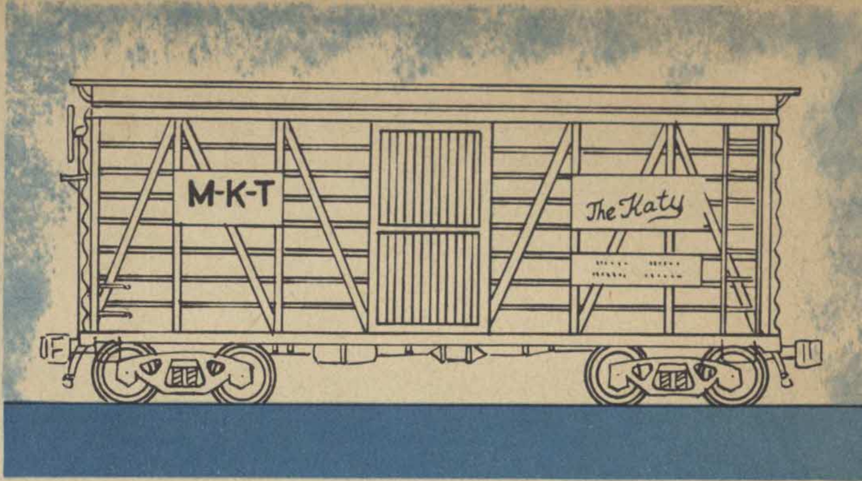
This specially built depressed-center flat car carries items considered too large, too heavy, or too bulky to be loaded on a normal flat car or boxcar.



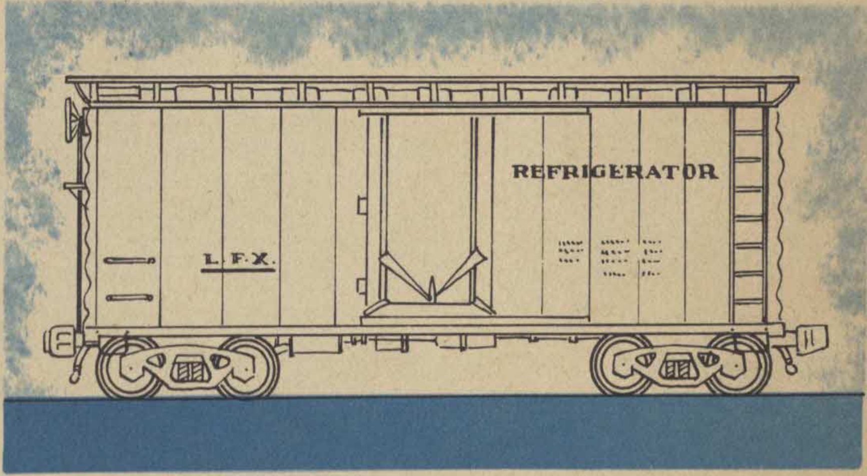
Gondolas are open-top cars with low fixed sides or fixed drop ends and flat bottoms. They are used for carrying iron, steel, gravel, stone, and other bulk freight.

Hoppers are cars for carrying such things as coal, ore, and sand. They are open on the top for loading and are emptied through the two chutes in the bottom.

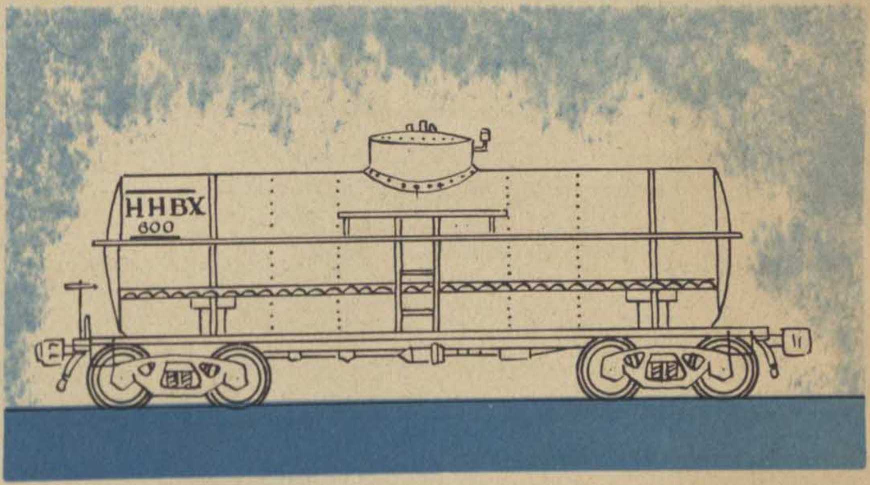
Stock cars are like boxcars but have side walls made of slats. They are used to carry cattle and other livestock to market.

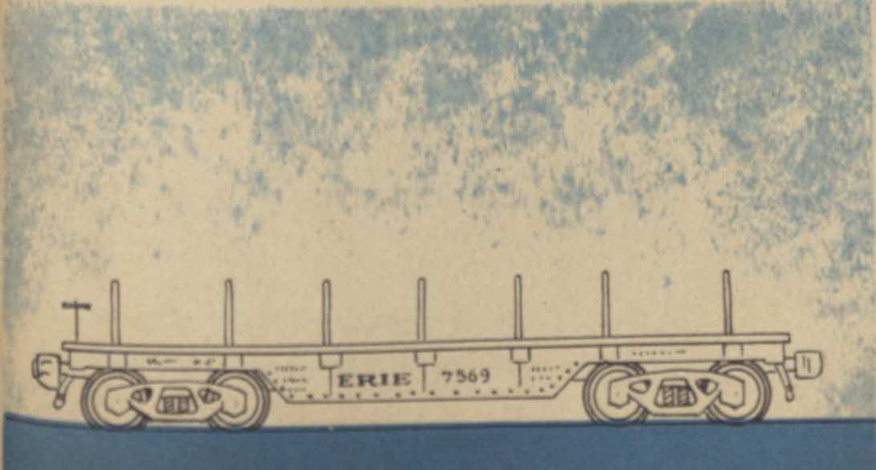


A reefer is a refrigerator car. While it looks like a boxcar, it is insulated like an icebox. It is used to transport food and other commodities which must be kept cold.

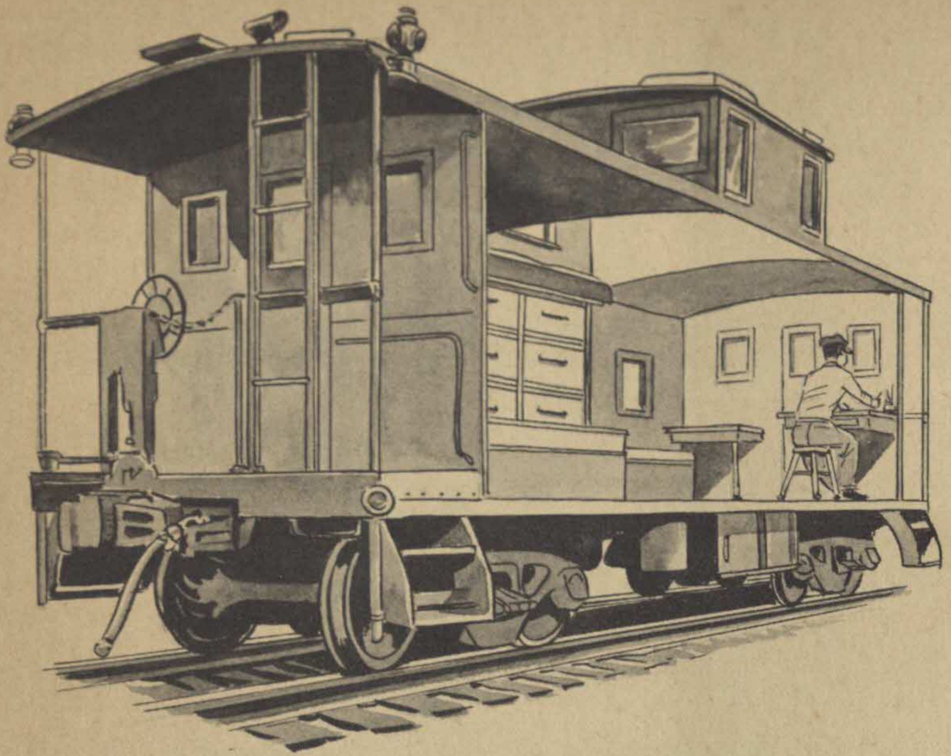


Tank cars, often called "bottles on wheels" are used to carry all sorts of liquids like oil, gasoline, and chemicals. Milk and orange juice are sometimes transported in cars with large glass-lined tanks.





A flat car is simply a sort of platform supported by wheels. They are widely used in transportation of loaded highway truck trailers. This is known as trailer-on-flat-car, or piggy-back, service.



The last car on every freight train, the caboose, is the train's office and home of the train crew while they are on the road. It is equipped with a stove, a drinking-water cooler, chairs, bunks, a washstand, lights, and other conveniences. It also has a desk for the conductor, lockers for members of the crew, the necessary flags, lanterns, light repair tools, oil, and other supplies. Doors open onto platforms at each end of the caboose. Located there are ladders to the roof and the hand brake wheels which operate the brakes when the caboose is not attached to a train. Brackets on the corners of the car hold the marker lamps, which show that it is the rear of the train. From a little watchtower or cupola on top of the caboose, the conductor and rear brakeman watch the train of cars ahead. Some cabooses have "bay windows" instead of cupolas.

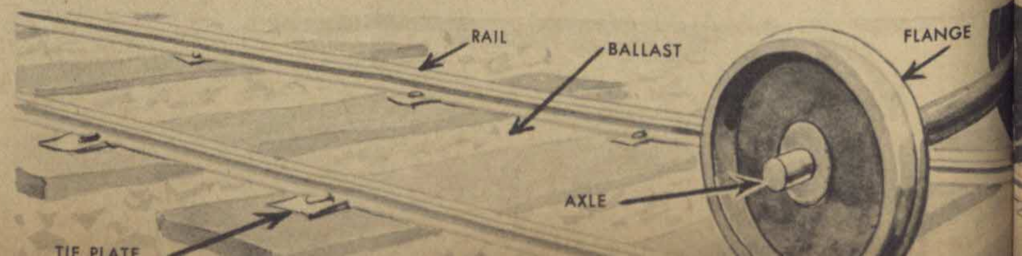
The caboose is only for the train crew, but occasionally the conductor will permit a non-railroad man to ride in it. The most famous caboose-rider was Abraham Lincoln. Before he was President, he generally preferred the caboose to the passenger coaches. To permit a view of the inside, the artist did not show a side wall.

be kept on record by various conductors and accounting departments.

Many persons wonder how it is possible for each railroad to keep constant track of its wandering freight cars. This is done by an elaborate, nationwide system of checks and reports. As soon as a freight car leaves its own railroad and moves onto the rails of another railroad, the station agent at the junction point reports the interchange movement to the *car record office* of his railroad. Thus, by daily reports, the car record office is kept informed of the progress of the car. Through these offices and a car's waybills, a car or shipment can be quickly located at any time.

One basic rule provides for getting cars home from "foreign" lines. When a car is emptied it must be sent back to, or toward, the owning line. It can carry a load if one is available; otherwise it travels empty. The railroad on whose tracks the car is standing or moving must pay the owning line a *per diem*, or daily rental charge, whether the car is loaded or empty. This charge is the same for all railroads.

Main parts of the track and wheel illustrate how the wheel is kept on the rails.



Tracks, Tunnels and Bridges

What is a railroad track?

In these days of shiny streamlined passenger trains and fast freights, we sometimes forget that the track comes first. But railroad men do not forget that fact. Take a ride along any stretch of railroad track. Sooner or later, you will see crews of men working on the tracks and roadbed.

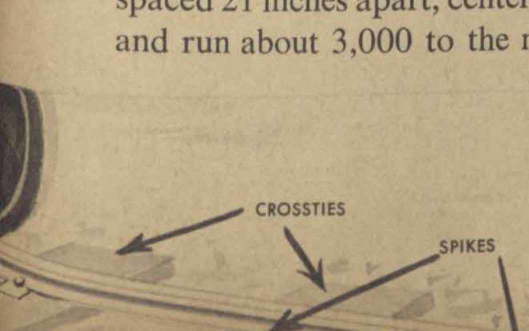
A modern railroad track is a highway of parallel steel rails. The track supports the weight of trains, furnishes a smooth way for trains to run upon, and guides the wheels of the cars. But, before the tracks can be put down, the railroad must receive a *right-of-way*. This is the strip of land, of various widths, upon which the railroad is built. It is wide enough to provide for tracks, drainage, signals, bridges, telegraph and telephone lines, sidings, and buildings.

After the right-of-way is obtained, the earth is made as level as possible for the roadbed. On the roadbed, the track is laid. To make the train ride smoothly, the track must have a cushion under it. The rails are fastened to *tie plates*, which in turn are spiked to wooden *crossties*, or more simply, *ties*. The ties help support the rails in the track, while tie plates keep the rails from cutting into the wooden ties. The *spikes*, which are very big nails, hold both in place. The ties or crosspieces are usually spaced 21 inches apart, center to center, and run about 3,000 to the mile.

The ties are placed in crushed rock, gravel, or cinders, called *ballast*. Ballast drains water from the ties and spreads the load of the track evenly over the roadbed. It also holds the ties firmly in place and checks the growth of grass and weeds. Ballast is an important part of the cushion under the tracks.

Roadway workers now have track-laying machines, powered spike hammers, ballast tampers, ballast cleaning machines, and many other devices to help them. Hidden flaws in the rails cannot escape notice, either. *Detector cars* traveling over the rails discover these defects by noting the way the rails carry electricity. Defective rails are marked automatically with a daub of paint. Track workmen then replace the defective rails. Railroad men call this repair work *maintenance-of-the-way*.

Early track rails were made of wood capped with thin strips of iron. This did not prove satisfactory and in 1831, a new type of construction was worked out by Robert L. Stevens. He devised an iron form of rail known as the "T" rail (although in cross section it looks more like an "I"). The base was flat and could be fastened by hook-headed spikes directly to wooden crossties. This arrangement not only supported the rails but held them in line and at the right distance apart. While the rail has changed from iron to steel and has grown in length, height, and weight, and in strength, safety and wearing qualities, the basic track ideas of the 1830's are still in use.

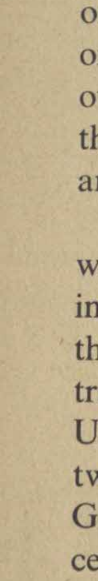


What keeps a train's wheels on the track?

Train wheels have a rim called a *flange* on the inside edge. This flange fits against the inside edge of the rail and keeps the wheel from slipping off the track.

The first iron rails weighed about 50 pounds per yard. Today, the weight of steel rails ranges up to 155 pounds per yard. The present standard length of rail is 39 feet. However, some railroads use rails 78 feet long in special locations such as highway-railway grade crossings and station platforms. While rails ends are generally joined together by means of two pieces of steel called *rail joints,* in recent years, standard-length rails have been welded together end-to-end to form continuous rails thousands of feet in length. In Colorado there is one stretch of continuous welded rail over six miles long. Welded rails remove the "clickety clack" from modern tracks and give a much smoother ride.

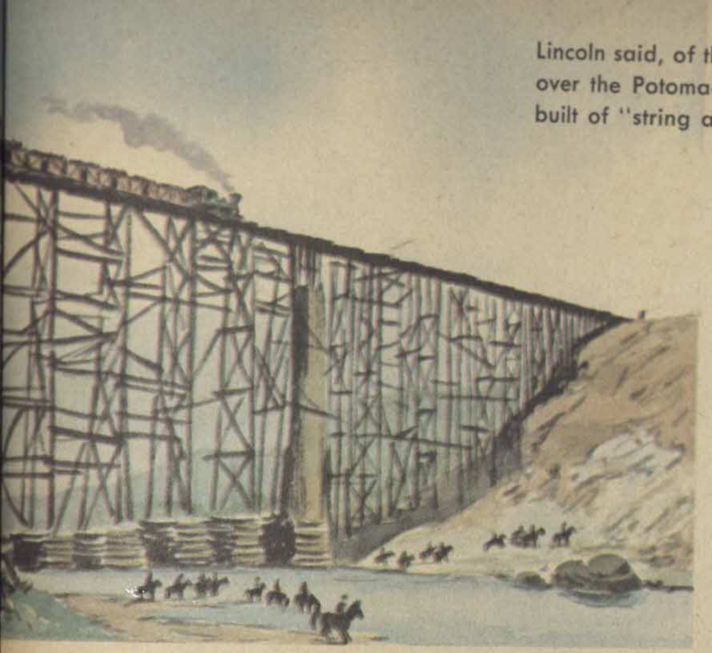
On American railroads the standard width or *gauge* of track is 4 feet 8½ inches between the rails. Originally, there were many different widths of track, both in England and later in the United States, varying all the way from two feet to seven feet. In England, George Stephenson built his first successful steam locomotives to run on a track with a 4 foot 8 inch gauge. Subsequently, this gauge was "eased" by adding a half inch. As railroads spread over the United States, many different widths were used, ranging from two to six feet. Cars from one railroad could not run on the tracks of another, so time and money had to be spent in transferring goods and people from one railroad line to another. Gradually, the railroads worked toward a standard gauge and, since 1886, virtually all tracks in the United States have been of the present width. Most railroads of Canada, Mexico and Cuba also use the same standard gauge.



When a roadbed is laid out, the tracks are laid as straight as possible. But sometimes curves in the roadbed are necessary to avoid hills, rivers, and ravines. Railway curves range all the way from a fraction of one degree (1/360 of a circle) to as high as six degrees. In some rare instances in mountain regions, railroads have curves as great as 10 or 11 degrees. However, a train does not tip over because the rail on the outside of the curve is higher than the rail on the inside — just as a highway is "banked" at a curve.

What is the grade of a track?

The *gradient* or *grade* of a track is the rate of ascent or descent. A perfectly level track has what is called zero grade. A rise of one foot in 100 feet of track is known



Lincoln said, of this early railroad bridge over the Potomac, it looked as if it was built of "string and bean poles."

as a one per cent ascending grade; a rise of two feet in 100 feet is a two per cent ascending grade, and so on. In mountainous territory, grades up to three per cent or slightly higher are sometimes necessary. But, as a rule, grades in excess of two per cent on main lines in the United States are rather uncommon.

Why is the Kate Shelley Bridge famous?

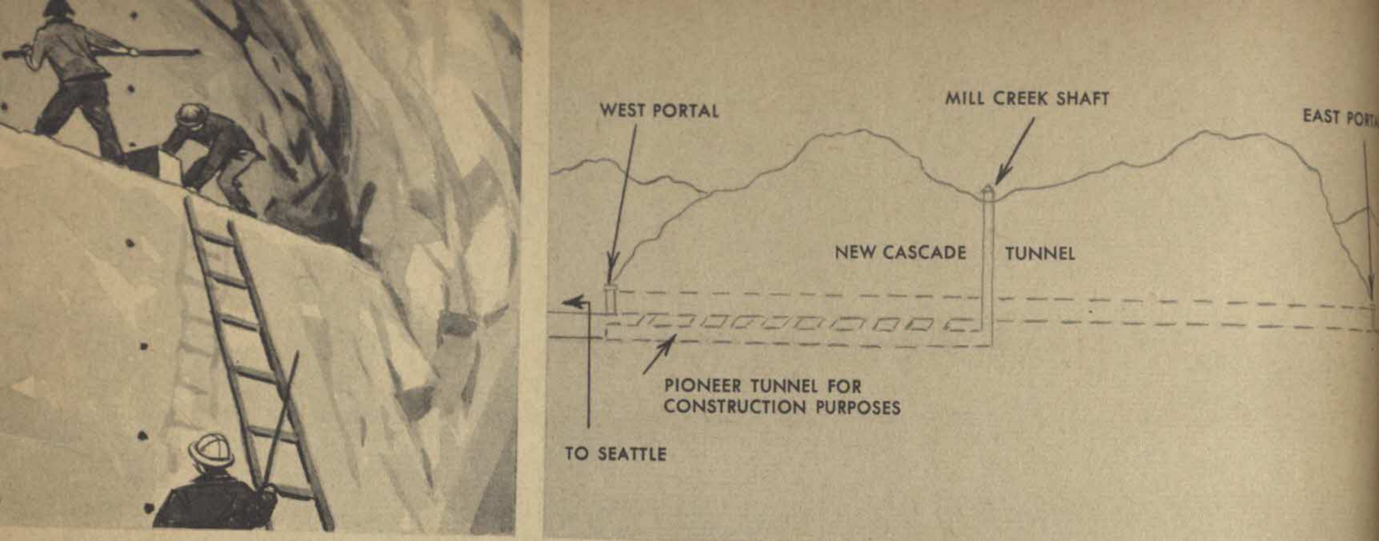
Bridges permit trains to cross rivers and valleys and to run from one city to another by more straight routes. There are about 192,000 railroad bridges of all kinds and sizes in the United States. The longest is twelve miles in length. Though many early bridges were made of wood, most of the modern ones are built of concrete and steel. The "legs" of the bridge are called *piers*. The section between two piers is called a *span*. The "floor" of the bridge where the tracks are located is called the *deck*.

There are long bridges — the twelve-mile trestle across the Great Salt Lake is the longest. There are spectacular bridges like the Niagara suspension bridge built in 1855. But to railroad men the small Kate Shelley Bridge across the Des Moines River is the one they love the best. The reason is simply that it was named in honor of their favorite heroine — Kate Shelley.

Kate, the daughter of a Chicago & Northwestern Railroad section hand, lived in a house by the tracks near Boone, Iowa. On July 6, 1881, a terrible storm swept across Des Moines Valley causing all the rivers and creeks to rise, including the one next to her house. Shortly after eleven o'clock that evening, Kate and her mother heard a freight train rumble onto the creek bridge, then the crack of breaking timbers, and a terrific crash of the engine as it went through the bridge.

Grabbing a lantern, the fifteen-year-old girl ran out in the storm knowing she had two jobs to do. First, she had to get help for the men in the wrecked train and second, she had to stop the midnight express before it plunged into the water, too. Reaching the broken bridge, she found two of the men had escaped and were safe for the time being. She shouted down to them that she was going for help for them and to stop the passenger train. The next station was only a mile away, but Kate had to cross a high bridge more than 500 feet long over the Des Moines River. There was no footpath on the bridge and she had to creep across it on hands and knees. To make it worse, the wind blew out her lantern and she had to keep going in the dark.

At last Kate reached the station and told the station agent her story just a



The workers load drill holes with powder for blasting operations during building of the Cascade Tunnel. At right, a diagram of the route of the Cascade Tunnel.

few minutes ahead of the express, which was not supposed to stop there at all. Picking up a red lantern, he reached the platform just in time to stop the express. A short time later a rescue party pulled the two men out of the creek. The bridge across the river was named in her honor and her broken lantern can be seen in the museum in Des Moines.

When are railroad tunnels used?

Tunnels carry railroads below the surface of the earth. Like the bridge, the tunnel permits trains to run between cities by a more direct route. Trains can pass through mountains, instead of around them; and they can travel at a more level grade than would otherwise be possible. Tunnels also enable trains to pass under cities, rivers, and harbors. There are about 1,500 railroad tunnels in the United States. They range in length from 30 feet to nearly eight miles, which is the length of Cascade Tunnel in Washington State. This tunnel is the longest in the Western Hemisphere. Boring of the Cascade Tunnel was started from the eastern and western ends at the same time. When the construction crews met in the middle, they found that they were only a few inches out of line. This small error was easily corrected, of course.

What are the main and branch lines?

The direct route of track between cities is called the *main line* or track. Many railroads have two main line tracks beside each other. Trains can run in one direction on one track, and in the other direction on the other track. One track may be called the west-bound main track and the other the east-bound main. Or they may be called the south- and north-bound main lines. On some railroads where traffic is especially heavy, there are more than two parallel tracks. To make the most use of the tracks, *crossovers* — two connecting switches — are employed to permit trains to cross from one track to another. For example, let us say that the main line has four tracks — two going in one direction, two in the other. In this system, two trains moving in the same direction can pass each other. By using crossovers, a third train can also pass by switching from track to track around the first two trains.

In cases where there is only one main line track, sidings must be provided at certain places along the line. Here a train runs onto the siding and waits for the train from the other direction to pass. Sidings are also on two-track systems so that a fast train can pass a slow train going in the same direction. In this case, the slow train runs onto the siding and waits for the express train to pass. Sidings are connected to the main track by *switches.*

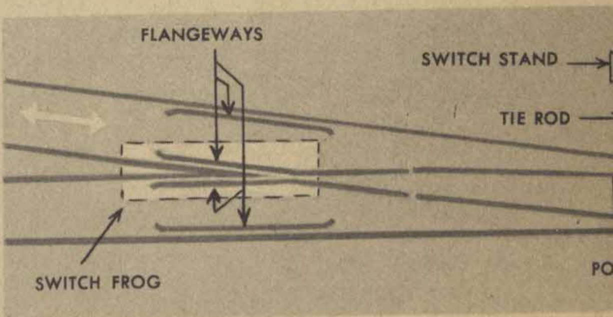
Switches have movable pieces of track that let trains move from one track to another. A track switch may be "thrown" when a trainman turns the handle of the switch or, as we will learn later, by a dispatcher in a traffic control center.

From the main line, there are usually several shorter lines branching off to smaller cities and towns. These are called *branch lines* and they act as feeders to the main line. Railroad stations at which these branch lines begin are called *junctions.* Junctions are also places where tracks come together or cross each other and they are controlled by switches.

Sometimes a section of track turns off from either a main or branch line to a factory, a lumber yard, or a coal yard. This section, called a *spur,* is where freight cars are pushed to deliver or take on their loads. At the end of the spur there is a strong, solid bumper to keep the locomotive and cars from running off the track.

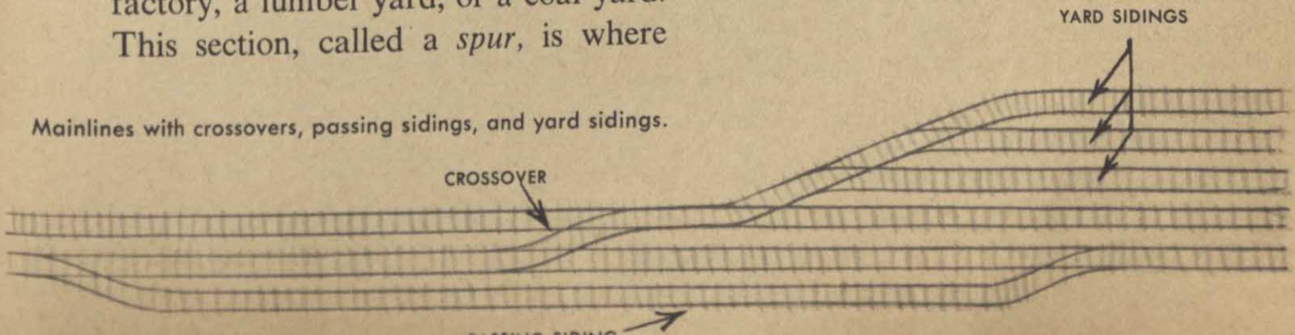
The ends of the main lines are called *terminals.* A terminal includes the railroad station proper and all the tracks and other facilities for handling mail, baggage, and express. It may also include a roundhouse, or engine house, switching facilities, fuel and water stations for locomotives, and coach yards where cars are stored when not in use. There cars are cleaned and inspected. In some terminals, automatic washers clean the outside of the cars as the train passes between revolving brushes.

Railroad offices, storehouses, shops, and other buildings are usually located within the terminal area and are part of its larger facilities. Passenger trains begin and end their journeys in passenger terminals. Between the terminal stations are smaller passenger stations or *ways* where the trains may stop.



Operation of switch.

Mainlines with crossovers, passing sidings, and yard sidings.



What is an enginehouse?

An *enginehouse* is a building to which locomotives are brought for light or heavy repairs. There, skilled mechanics repair or replace tubes, axles, wheels, brakes, or other worn-out parts, give it a fresh coat of paint, and make it almost as good as new. In the larger shops are huge overhead electric cranes which can pick up and carry a locomotive from one end of the shop to the other. Enginehouses are usually located at large terminals that also generally provide outdoor servicing facilities for locomotives, including water and fuel facilities.

Many smaller terminals have only a *roundhouse* — so named because it is a circular or semi-circular shaped building. Locomotives come here for cleaning and for minor repairs. The roundhouse has many stalls for the locomotives and below the track of each stall there is a pit or open space where the repairmen can work on the engine from below.

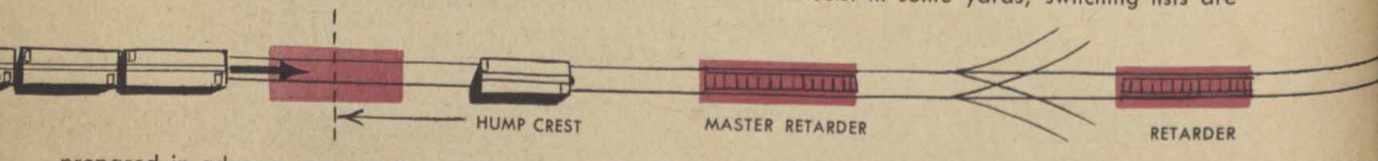
An important part of every roundhouse is the *turntable*. This is a section of track that revolves over a round pit and it makes it easy to turn a locomotive into the proper position to be run into the roundhouse stall where it is to receive attention.

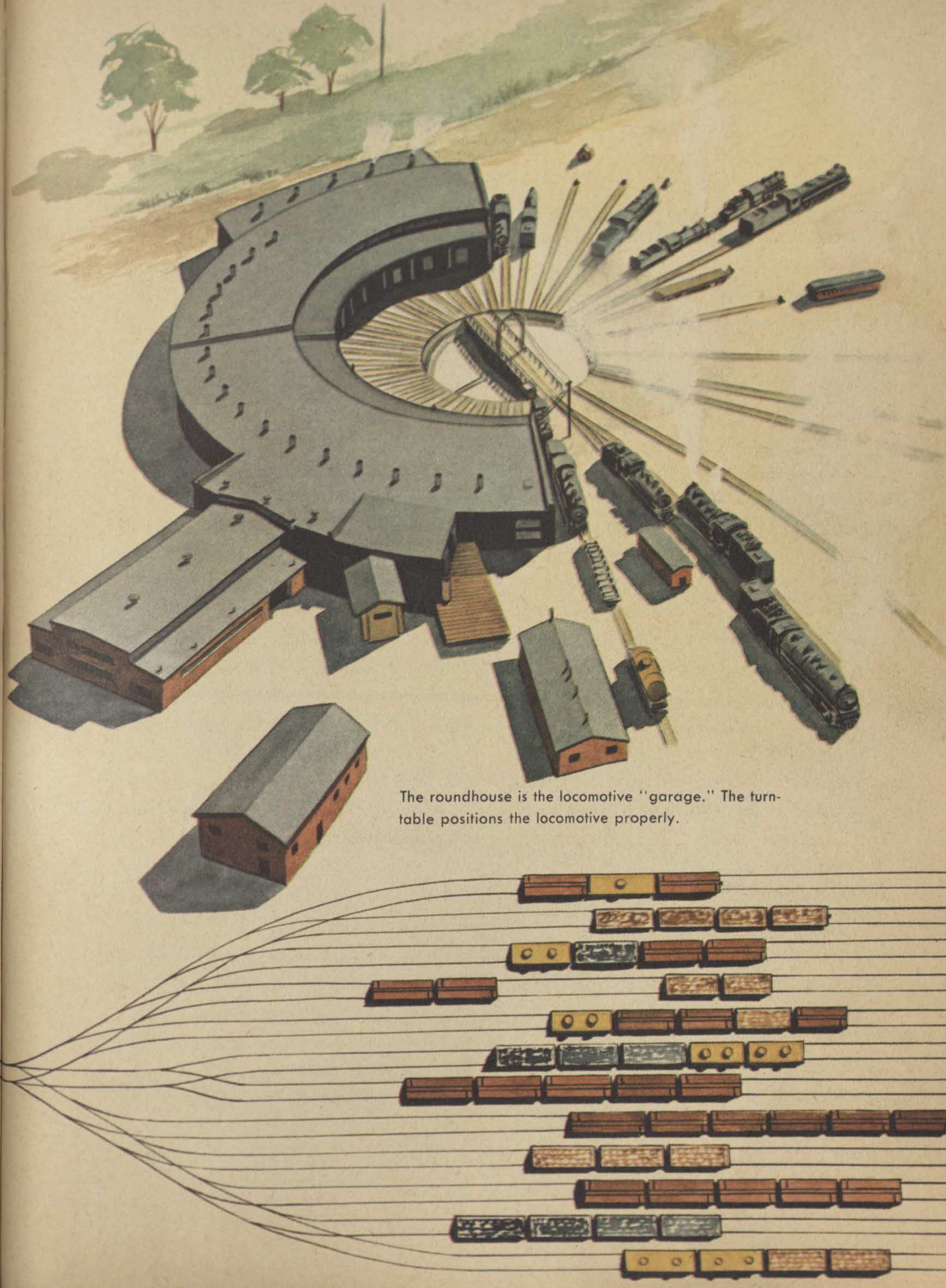
Railroads also have shops for repairing freight and passenger cars. Car inspectors examine incoming passenger and freight cars at important stations and terminals to make sure that they are in good condition. Car inspection helps to promote safety and prevent delays in train schedules.

What is a freight yard?

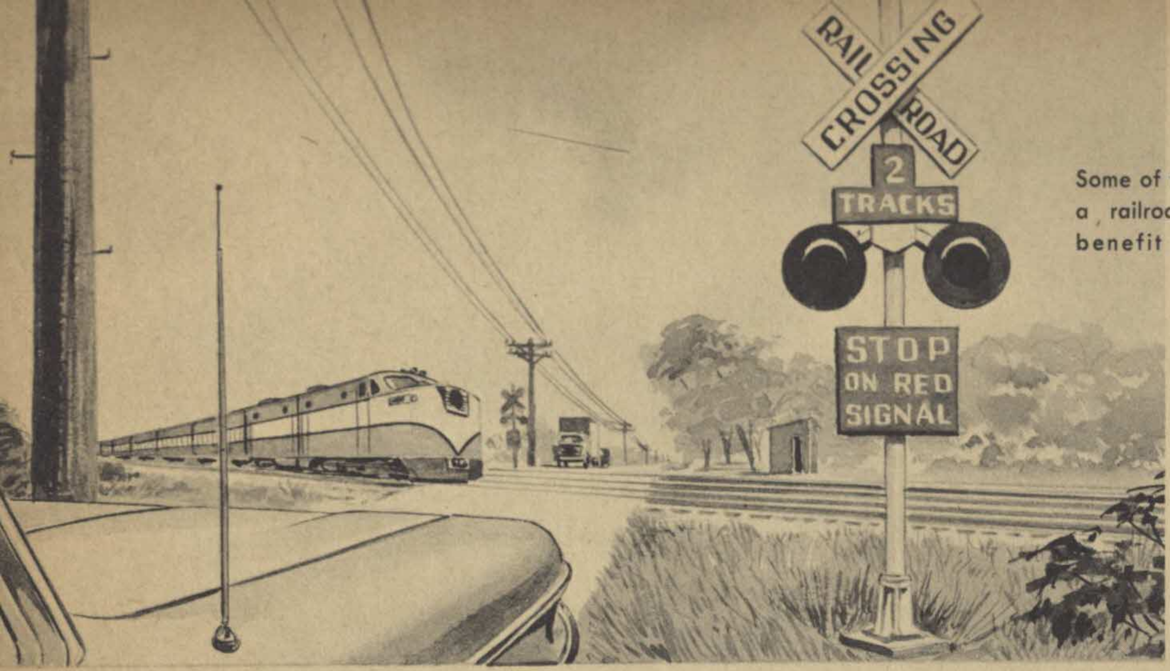
Freight trains begin and end their runs in freight yards. These yards are made up of groups or sets of tracks, connected by switches. There are *receiving tracks* for incoming trains, *classification tracks* on which cars are sorted out for other trains, and *departure tracks* where outgoing trains are assembled. There are also *storage tracks* to hold cars, and *rip tracks,* where the cars are repaired. There may be *house* or *transfer tracks,* where freight is loaded and unloaded at stations, and *team tracks,* where trucks are used in handling freight. In these yards, powerful floodlights make uninterrupted night operations possible.

Many large yards in which freight train cars are distributed and made up into other trains are built with an elevation or "hump" in the middle. Switch engines push trains or cars to the top of this hump. There, the cars are uncoupled and allowed to run down the slope. An operator called the yardmaster, in a control tower, checks the number of each car against his switching list. This list tells the yardmaster the number and weight of every car, where it is going, and the number of the yard track where each car belongs. He sets the switches so that the car goes to the right track. To slow down or stop the car, he presses a button or moves a lever which causes retarders in the tracks to "squeeze" the sides of the car wheels. In some yards, switching lists are prepared in advance on special computer systems which automatically select the proper route for each car. Entire tracks can be classified by pushing a single button. A mile-long train of a hundred or more cars can be handled and sorted in less than half an hour with only a switching engine and the help of gravity. As many as three thousand incoming cars have been handled in a modern freight yard in a single day.





The roundhouse is the locomotive "garage." The turntable positions the locomotive properly.



Some of the signals along a railroad are for the benefit of the public.

The Eyes and Ears of the Railroad

How are train movements regulated?

From the very earliest days of railroading, various kinds of signals have been used to keep trains from running into each other. One early type was called a block-board. At each station, a red board was put upon a high post. It was the station agent's duty to set the board for each train. When the board stood out straight over the tracks, trains had to stop. At night a red lantern was hung on each end of the board.

Another early signal system consisted of a colored ball (a lantern was used at night) which could be hoisted to the top of a pole beside the track by a station agent. When at the top, it meant that the track ahead was clear — hence the railroad term *highball,* meaning full speed ahead.

Timetables next governed the movements of trains. At certain times, a train was supposed to pull onto a siding to let another train pass. If the second train was late, the first simply waited—sometimes for hours. Telegraphic train orders solved these problems and helped to make railroads safer. Then came the block signal system which was first hand-operated and then automatic.

What are block signals?

On busy railroad lines, where there are many trains, there are "traffic" signals along the tracks to tell the engineer of an approaching train what to do: These are called *block* signals because they divide the railroad tracks into sections or "blocks" and are so spaced that trains will run a safe distance apart from each other. By watching the signals, trainmen know whether or not another train is in the block. Some of the block signals are operated electrically from signal towers or stations. Many others are operated automatically by electric current flowing through the rails. As long as all switches are closed, and no train or other obstruction is in the block, the signal shows "clear." When a train enters the block, its wheels and axles short-circuit the current. The signal changes to "stop." Usually, the signal circuits are arranged so that a "caution" signal shows when a train is in the *second* block ahead. Thus, as the trains move along the tracks, changes in the electric circuits in the rails automatically cause the signals to change, giving their messages to the engineer through semaphores and lights.

Semaphores are signals with movable blades or "arms" on posts beside the track or on "signal bridges" above the track. From the position of the arms, the engineer knows when to stop, when to go slowly, and when to go ahead at regular speed. For example, when the arm is straight up (vertical) it means the track is clear; halfway up or down (diagonal), caution; straight out (horizontal), stop. Colored lights show the position of the arms at night. Green light means clear track — proceed at regular speed; yellow light means caution; and red light means stop.

On many railroads, lights are used for signals both day and night. In some cases these are *position light signals* which are like semaphores except that they have rows of yellow lights instead of semaphore blades. Other railroads use *color light signals* — green, yellow, and red — which are visible by day as well as by night. Still others use a combination of position and color lights.

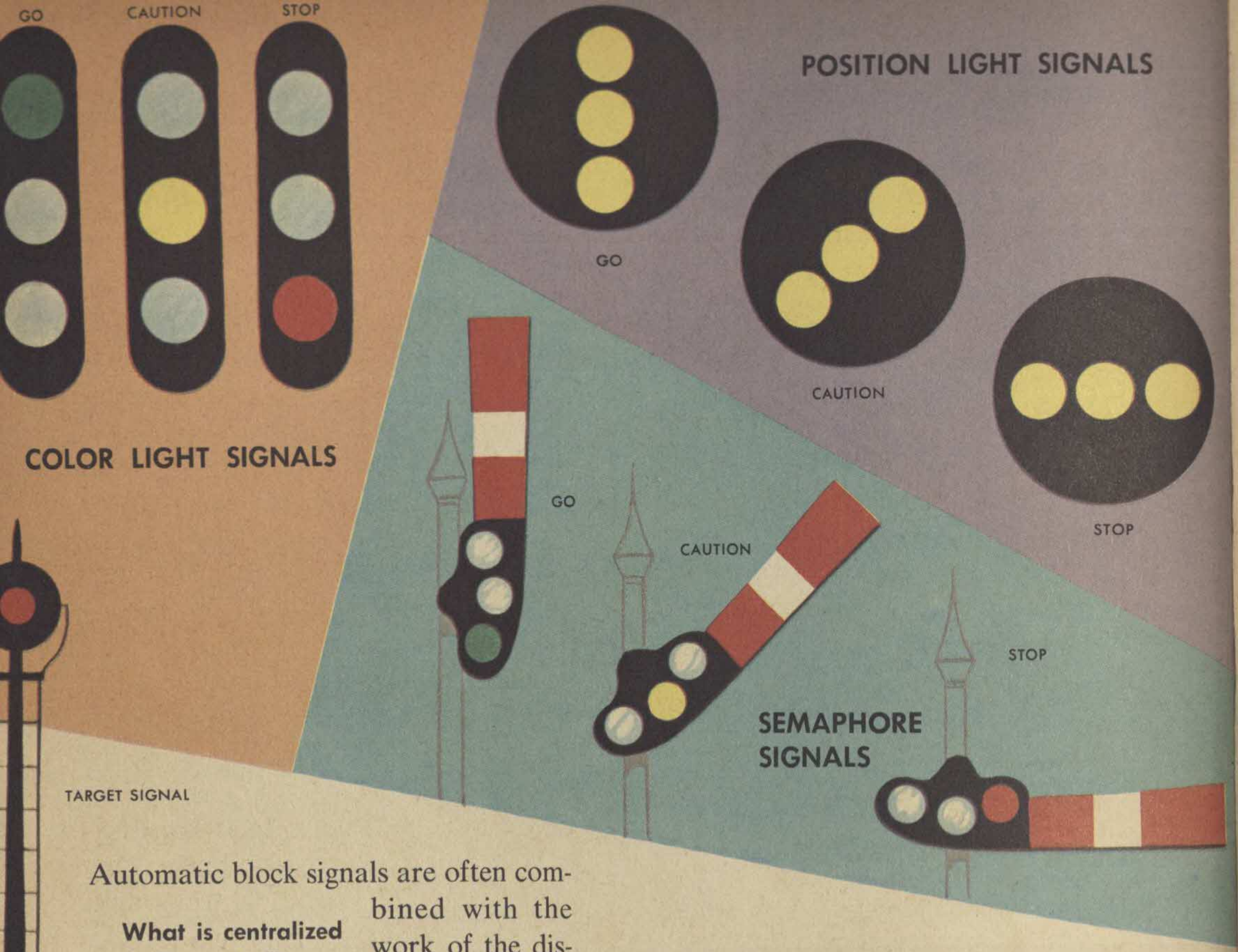
In some block systems, the signals are repeated in miniature inside the cab in front of the engineer. This makes it safer to operate a train in fog or stormy weather. On some lines, an automatic train control stops the train if the engineer does not obey a stop signal.

Where there are many tracks, sidings, crossovers, and switches, the signals are often controlled from a *signal tower*. Here, the *towermen* can operate them by moving levers and, in addition, can work the switches from the tower to move a train onto a siding or from one track to another.

Who controls the movement of all the different trains?

The train *dispatcher* is responsible for the proper movement of trains. He sits in a central office along the rail line with a large train sheet before him. On this sheet, he notes the position of every train operating over the line. As the train leaves the station, he notes the time, the number of cars, the names of the crew, and the number of the locomotive. As the train passes each station, the time is telephoned to the dispatcher by the station agent or a towerman. Thus, he knows the location of every train.

In case of delays, the dispatcher may make up special orders. These orders are telephoned or telegraphed to a station ahead of the train. On some lines, the station agent attaches copies of the orders to large hoops. As the train passes, he stands beside the track and "hands up" one hoop to the locomotive and another to the caboose. Members of the crew catch the hoops on their arms as the train goes by. Sometimes the hoops are placed one above the other on a metal frame called a *train order standard*.



What is centralized traffic control?

Automatic block signals are often combined with the work of the dispatcher in the operation known as *centralized traffic control,* or, in railroad language, *CTC.* Under this arrangement, each train on the line automatically reports its position and movements through electric lights on a track map panel in front of the train dispatcher. That is, lights on the panel map show the location and progress of all trains at all times. With this information before him, the dispatcher arranges train movements with minimum delay and interference. He issues orders for such movements through signals operated by moving levers or by pushing buttons on the panel to route trains in and out of siding or up the main track. In some cases, these signals may be two hundred or more miles from the panel, but they are so arranged that the dispatcher can set rail switches and block signals at such distances. The system is so interlocked that it is impossible to have the signal give an indication that is contrary to the position of the switch. With CTC, almost as much traffic can move over a single-track as over a double-track line.

Are signals needed between crew members?

Signals are constantly needed between different members of train crews. A freight or yard brakeman must signal to the engineer while cars are being coupled together to form a freight train.

The conductor must be able to communicate with the engineer. The engineer must inform the rest of the crew — and also the public — that they are approaching crossings or stations. In the event of an emergency stop, both ends of the train must be protected by flags, torpedoes, flares or lantern signals. Along the line, many visual signals tell the engineer how to proceed, to remind him to blow the whistle, etc. At grade crossings, the railroad signals the public to stop by using gates, signs, lights, bells, or some combination of these.

On most freight trains, hand, flag and lantern signals are used to furnish end-to-end communication. For example, a hand, flag, or lantern swung horizontally across the track means stop; held straight out from the side at arm's length, reduce speed; raised and lowered vertically, proceed; swung horizontally above the head, when standing, apply air brakes; held at arm's length above head, when standing, release air brakes.

Inside a passenger train, the conductor can signal the engineer in the cab with a *bell-cord* which runs through each car and that blows a soft air whistle. Next time you ride a train, listen for these communication signals:

Two short sounds: When standing; start. When running; stop at once.

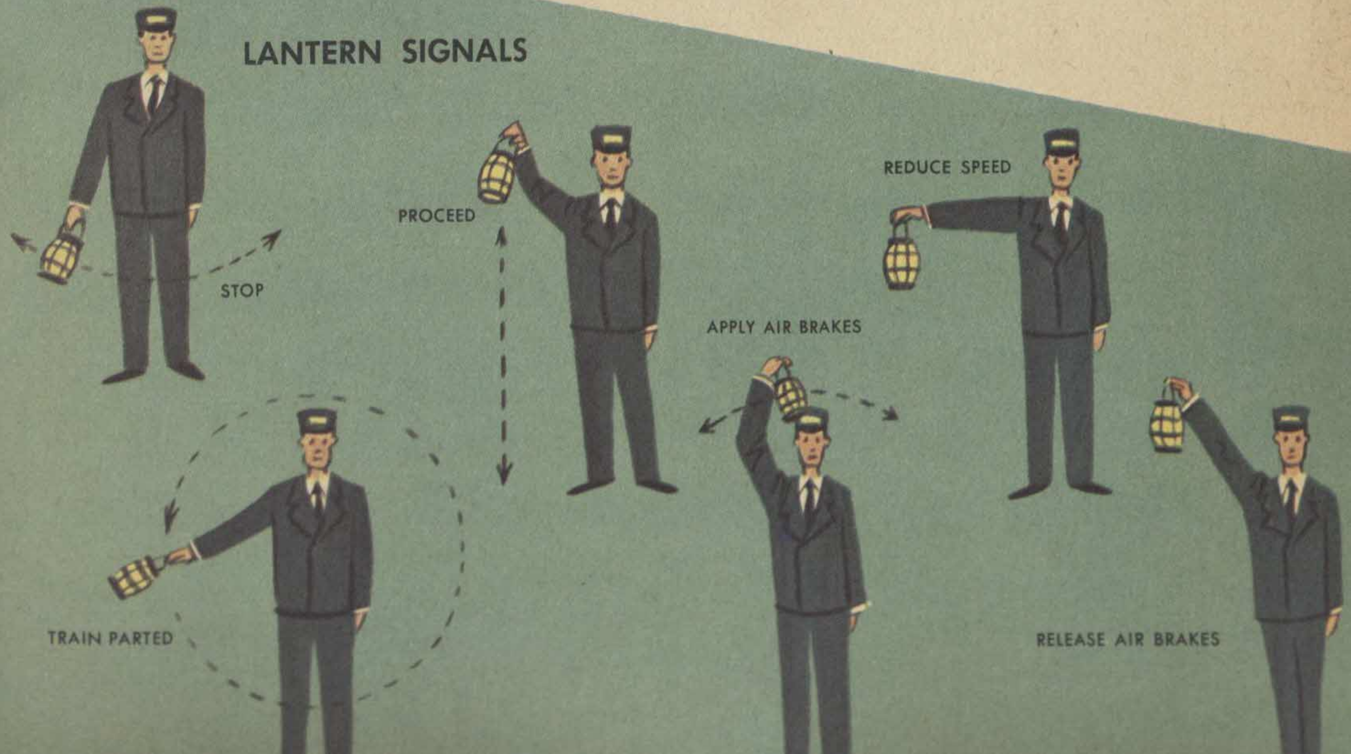
Three short sounds: When standing; back up. When running; stop at next passenger station.

Four short sounds: When standing; apply or release air brakes. When running; reduce speed.

Five short sounds: When standing; recall flagman. When running; increase speed.

How are radio and television used by railroads?

On many railroads, radio is used for communication between conductor and engineer on both freight and passenger trains, and between dispatchers and train crews. On



some trains, passengers may talk by radiotelephone with their homes or offices. In many freight yards, radio is used for two-way communication between switching crews and yard offices.

Television is being used increasingly in railway yard and train operations. Television cameras, for example, take a picture of each car as it passes a given point and transmits it to the car record office where it is recorded. Television is also used to enable railway safety men to check traffic conditions and to watch and sound warnings at railway-highway grade crossings.

Other uses for television (actual or suggested) include theft detection, trainmaster supervision of yards or terminal operations, coal dumping operations, traffic counts, train space reservations, and research studies of equipment in operation.

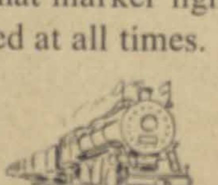
What do the different engine whistles mean?

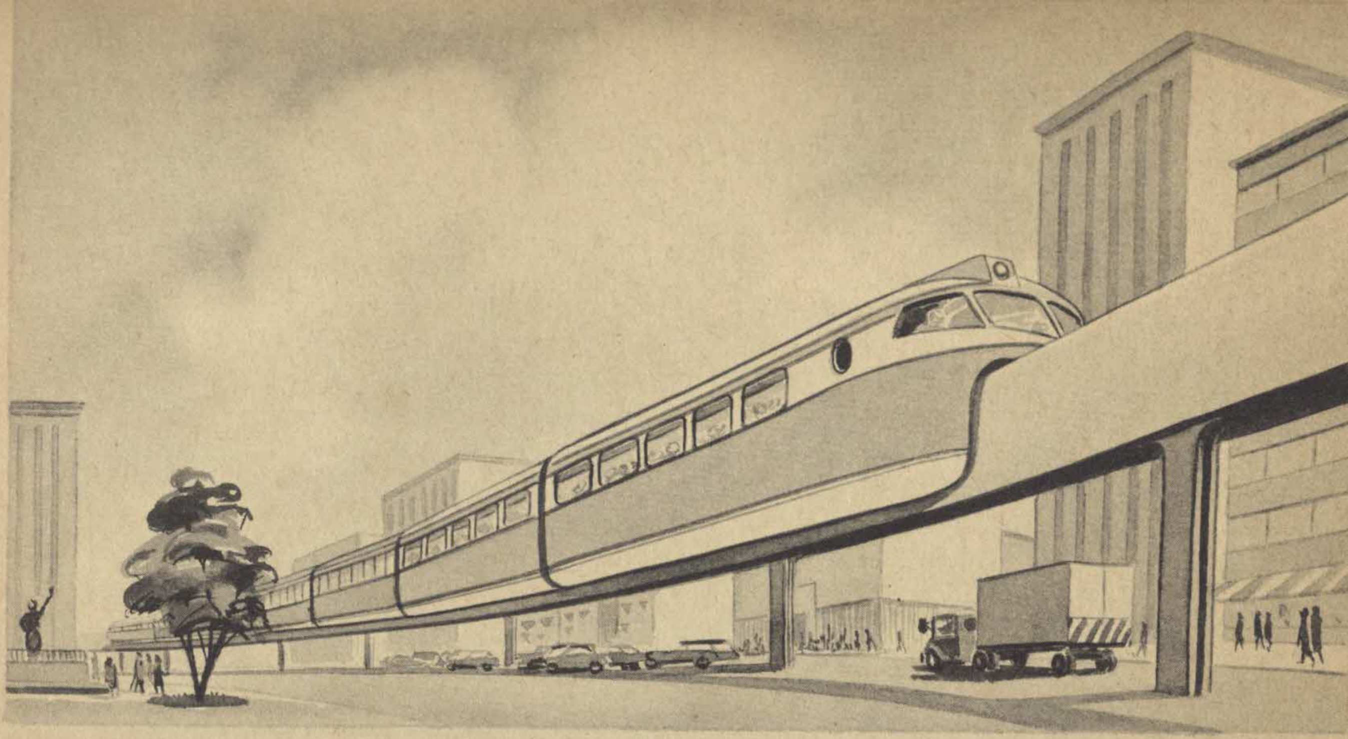
Believe it or not, railroad engineers do not blow the locomotive whistle just for the fun of it. Every toot has a meaning and helps to keep the wheels rolling. Some of the whistle "talk" used by the engineers is given here, so that you may know what the engineer is saying the next time you hear the whistle echoing over the countryside. Each · (dot) means a short toot. Each — (dash) a long toot.

— — — — Approaching station, junction, or railroad crossing.
— — · — Approaching public grade crossing.
· · — Approach meeting, or waiting, points of trains.
· Apply brakes, stop.
— — Release brakes, proceed.
· · · — Flagman protect front of train.
— · · · Flagman protect rear of train.
— — — — Flagman may return from west or south.
— — — — — Flagman may return from east or north.
· · · When standing: back up. When running: stop at next station.
· · · · Call for signals.
— · · To another train, *a second section is following.*
· · Engineer's answer to most signals from other trains.
A number of short toots: Alarm for persons or animals on tracks.

What flag and light signals are used on the engine?

It is possible to tell something about the operation of a train by looking at its locomotive. If the engine carries two white flags, it means that the train is an extra — one that is not on the railroad timetable. At night, this train would display two white lights in place of the flags and in addition to the headlight. If the flags and lights are green, the train is in two sections and the second section is following right behind. If the locomotive shows neither flags nor side marker lights, the train is one of the railroad's regularly scheduled trains. The rear car of all trains carries red marker lights. The conductor must make sure that marker lights are properly displayed at all times.





The Monorail is an interesting development in railroading. Will it be the railroad of the future?

What railroad signal must we all obey?

Not all signals are used by the railroaders. The *stop, look and listen* signal must be obeyed by all motorists and pedestrians at highway grade crossings. It tells them that they should *stop* on the red signal light. Where traffic is heavy, such crossings are usually protected by watchmen, or by gates, bells, flashing red lights, or other devices. When the train approaches a crossing, the engineer sounds the whistle, bell, or air horn as a warning to those on the highway. But we should all remember that the only safe way to cross a railroad track is to *stop, look,* and *listen.* If a train is coming from either direction, we should wait until it has passed before crossing the tracks.

Model Railroading

Model railroading is a favorite hobby of children and adults. It is so popular because it parallels the operation of a real railroad. It has many of the same features as a full-sized line, including miniature signals, switches, bridges, tunnels, stations, crossing-gates, sidings, etc. But the person who operates the model railroad does the work that would be done by a dozen or more persons on a real railroad. Thus, to run this small road smoothly, you must have skill, experience and knowledge of operation just as the people who run the big trains have. This skill is the fun of model railroading.

Model railroading is a favorite hobby for young and old.

Model railroad locomotives and cars may be purchased ready-made or can be assembled from kits. The tracks, signals, bridges and other vital parts of any railway system can be purchased and laid out by the model railroader, as he wishes, to make the operation interesting. Regardless of the type of locomotive, it is powered, in model railroading, by electric current carried in one of the rails.

A model railroad may cover as little as 8 to 10 square feet, or it may occupy a good part of a basement or attic. All railroad train models and equipment are built to an exact *scale*. (Scale refers to the relation in size between a model and the real thing — called the *prototype.*) In model railroading the most common scale is 3.5 millimeters to one foot, making each part of the model 1/87 the size of the prototype. These model trains use a *gauge* or track width, called HO. This width equals 16.5 millimeters, or about ⅝ of an inch. (Remember that real railroads use a standard gauge of 4 feet 8½ inches. See page 36.) The next most popular scale of model railroads is ¼ inch to one foot. This makes the model 1/48 the size of the prototype. It runs on 0-gauge tracks that are 1¼ inches wide.

Acknowledgments: For their help in making this book possible, the author wishes to thank the Association of American Railroads, Santa Fe System Lines, Union Pacific Railroad, Great Northern Railway, and finally my father, a long-time employee of the New York Central System, who first interested me in railroading.

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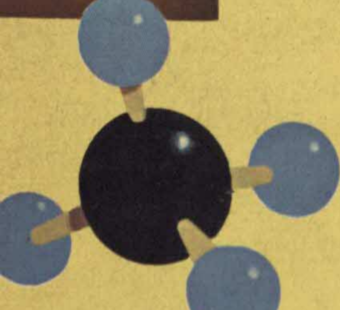

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